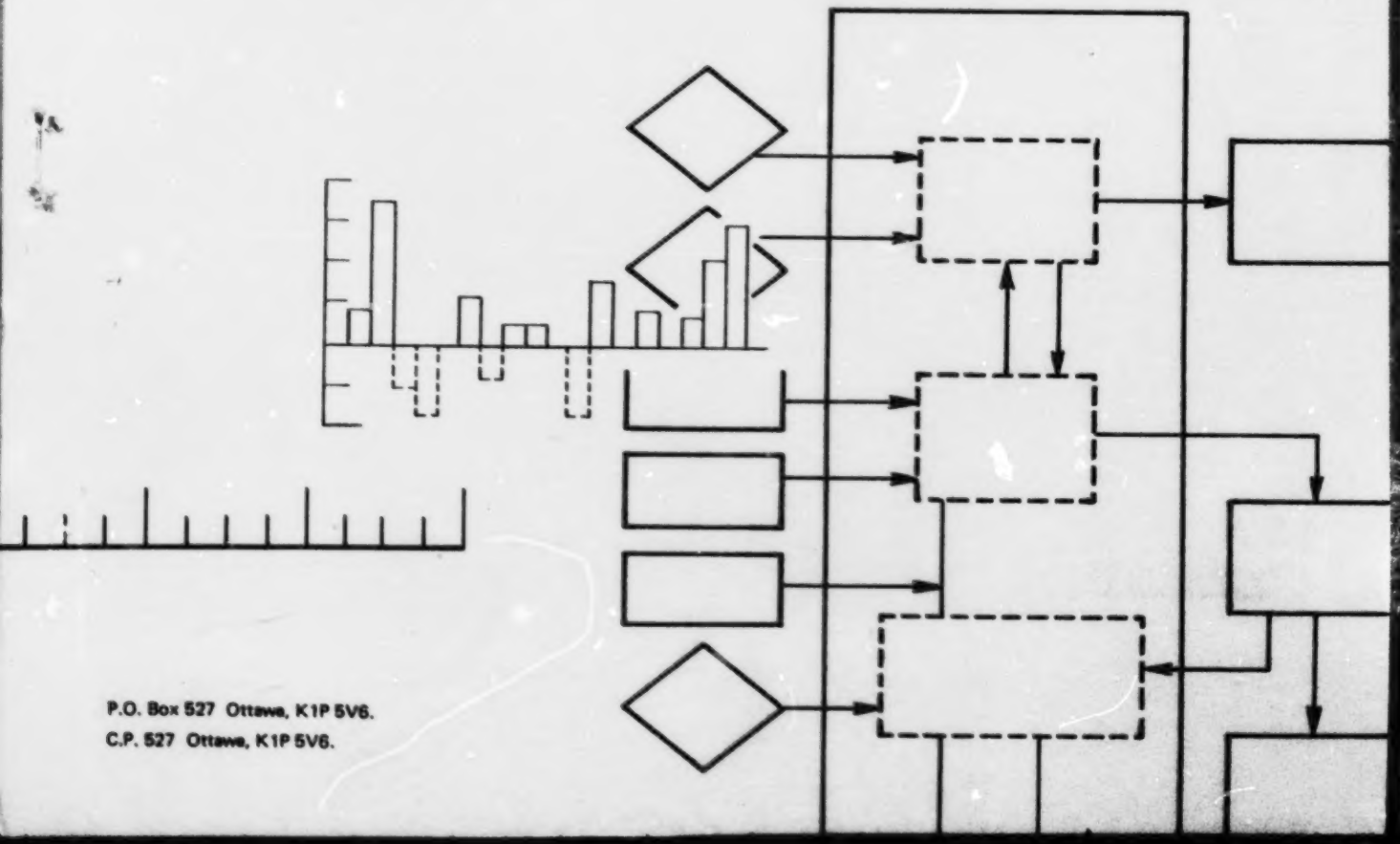
A paper prepared for the

Economic Council of Canada

Un document préparé pour le

Conseil économique du Canada



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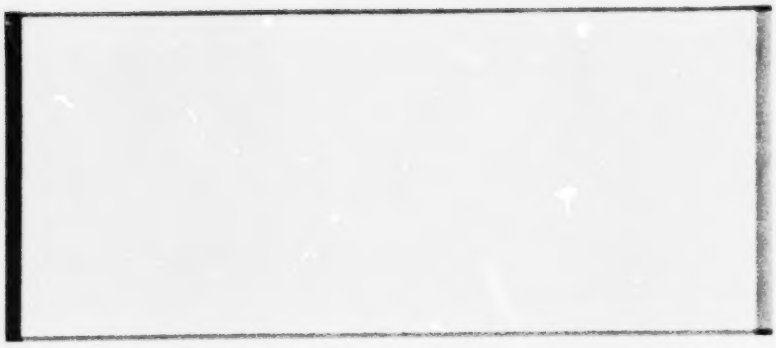

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DISCUSSION PAPER NO. 222

International Energy Comparisons A View of Eight Industrialized Countries

by Bobbi Cain
assisted by Pat Nevin

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ISSN-0225-8013

December 1982

RÉSUMÉ

Au cours des dernières décennies, les Canadiens ont acquis la réputation d'être des consommateurs insatiables d'énergie. Cette réputation est-elle méritée, ou nos perceptions ne sont-elles pas plutôt nuancées par notre façon de mesurer cet appétit, surtout en le comparant à des mesures semblables relevées chez nos partenaires commerciaux ?

Dans le présent document, l'auteur établit des comparaisons entre les besoins totaux d'énergie tirée des divers combustibles et la consommation observée dans les différents secteurs de l'économie pour un échantillon de huit pays industrialisés au cours des décennies 1960 et 1970. L'échantillon comprend le Canada, les États-Unis, le Royaume-Uni, l'Allemagne, la France, l'Italie, la Suède et le Japon. L'ensemble représente une grande diversité de sources énergétiques et de modes de consommation. Ces derniers sont présentés dans un graphique pour une année de la fin de la décennie 1970.

Les besoins en énergie -- le facteur énergie qui répond aux besoins en combustible pour les utilisations intermédiaires et la consommation finale d'énergie -- sont comparés non

seulement dans leur total pour chaque pays, mais aussi par habitant et par unité de production. L'utilisation intermédiaire d'énergie, dans le secteur de la transformation, comprend les besoins énergétiques pour la génération et la production des diverses formes d'énergie. L'auteur souligne le fait que ce secteur ne revêt pas le même degré d'importance dans les diverses économies. Il définit la consommation d'énergie comme les besoins totaux moins l'énergie requise par le secteur de la transformation. Les comparaisons portent sur la consommation totale d'énergie, la consommation par habitant, par unité de production, et enfin par secteur et par type d'énergie.

L'auteur compare aussi le degré de dépendance des diverses économies à l'égard du pétrole brut importé au cours des deux décennies. Il fait ensuite un bref exposé des prix énergétiques, tant nominaux que réels, et de la taxe sur l'essence.

Il ressort de ces comparaisons que la conclusion générale selon laquelle les Canadiens seraient des consommateurs d'énergie inefficaces et prodigues est une simplification à outrance qui ne tient pas compte de facteurs tels que les tendances de la population et de la production réelle. L'auteur ne tente pas d'apporter des corrections complexes pour des facteurs tels que le climat, le patrimoine foncier et autres

considérations géographiques. Cependant, ces facteurs aussi devraient être évalués avant d'en venir à un jugement définitif sur les habitudes des Canadiens en matière de consommation d'énergie.

L'auteur fait un examen rapide des tendances observées dans les pays compris dans l'échantillon concernant les prix et l'imposition des produits énergétiques. Cette examen confirme le fait que le Canada a eu le privilège de pouvoir compter sur des sources d'énergie abondantes et facilement accessibles durant les deux décennies en question. Au cours du dernier demi-siècle, la structure de l'industrie canadienne a évolué à partir de cette notion, pour le plus grand avantage aussi bien du secteur interne que du secteur externe de notre économie.

ABSTRACT

Canada is reputed to have had a seemingly insatiable appetite for energy over the recent decades. Is this reputation justified or are our perceptions coloured by the manner in which we measure that appetite, especially in comparison with similar measures for Canada's trading partners?

This paper presents comparisons of total energy requirements of all fuel sources and of consumption within the various sectors of the economy for a sample of eight industrialized countries over the decades of the 1960s and 1970s. That sample includes Canada, the United States, the United Kingdom, Germany, France, Italy, Sweden and Japan. This set represents a broad diversity of energy source and consumption patterns, patterns which are presented graphically for a year in the late 1970s.

Energy requirements -- energy inputs that fulfil fuel requirements for intermediate use and for final energy consumption -- are compared not only in total, but also in per capita terms and in requirements per unit of output. Intermediate energy use, or the transformation sector, includes energy requirements for generation and production of energy forms. The differing importance of this sector in the various economies is highlighted. Energy consumption, which is defined as total requirements less those necessary for the

transformation sector, is compared in total, in per capita terms, in terms of per unit of output, and finally by sector and by energy type.

The dependence of the various economies in question on imported crude petroleum is compared over the two decades. We then turn to a brief discussion of energy pricing, both in nominal and real terms, and gasoline taxation.

In our comparisons, it was found that to generalize Canada as an inefficient, wasteful energy user was a considerable over-simplification without taking factors such as population and real output trends into consideration. We have not attempted to include a sophisticated adjustment for factors such as weather, land mass and other geographical considerations. Yet these, also, are factors that should be evaluated before producing definitive judgements on Canada's energy habits.

We have briefly reviewed trends in energy pricing and taxation in our country set. This review indeed confirms the notion that Canada has been able to rely on cheap, as well as plentiful and readily available, energy over the two decades in question. The structure of Canadian industry as it evolved in the past half century has been predicated on this notion, and it has been advantageous in both the domestic and international sectors of our economy.

ACKNOWLEDGMENTS

The author would like to express her appreciation to Ross S. Preston for his comments and helpful criticisms. The assistance of Pat Nevin in the preparation of the many tables and graphics and of Mary Rowe in the preparation of the manuscript is gratefully acknowledged. Any errors or omissions remain the responsibility of the author.

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INTERNATIONAL ENERGY COMPARISONS

I Introduction

"Canada uses more energy per person than any of her trading partners!"

"Canadians are wasteful energy consumers!"

"Energy is cheaper in Canada than in countries of her competitors, and has been for years!"

Statements like these frequent the media commentary. Are they justified, or are there special circumstances that cause most observers to misconstrue the true facts about Canadian energy consumption?

In this paper we will attempt to pursue questions such as this one. Comparisons of total energy requirements of all fuel sources and of consumption within the various sectors of the economy will be presented for a sample of industrialised countries. A brief survey will then be made of gasoline pricing and taxation trends. Our sample countries include Canada, the United States, the United Kingdom, Germany, France, Italy, Sweden and Japan. This set represents a broad diversity of energy source and consumption patterns.

II Comparisons of Energy Requirements

-- Total Energy Requirements

The total energy requirements of an economy are energy inputs of all types that fulfill fuel requirements for intermediate use and for final energy consumption within all sectors of the economy. Intermediate use requirements are classified as primary energy inputs into energy production industries such as electricity generation, crude petroleum refineries, gas production, plus losses in the production, conversion and transportation of fuels.

These requirements are supplied from indigenous production, net imports and stock changes. They come from many energy sources: solid fuels which, while mainly coal, also include renewable mass fuels such as wood and peat; electricity; natural gas; and crude petroleum.

Table 1 presents a comparison by type of fuel of total energy requirements for the years 1960, 1972 and 1979 for our set of countries. In order to be able to draw a comparison across the various energy sources, all fuel requirements have been expressed as millions of tons of oil equivalent (MTOE). To convert the data to this common unit in as consistent a fashion as possible, the OECD International Energy Agency, whose publication "Energy Balances of OECD Countries" made this exercise possible, used the

following approach. Coal and natural gas were expressed in terms of the quantity of oil which gave the equivalent amount of heat. Hydro and nuclear electricity were expressed in terms of the hypothetical amount of electricity in existing conventional thermal power plants.[1]

In Table 1, it is apparent that the United States is by far the greatest user of energy in absolute terms within our sample. However, we will later show that it is necessary to scale these energy requirements by measures such as population and output in order to draw more meaningful comparisons.

It is interesting to regard the areas of substitution evident over the period in Table 1. In 1960, 73 per cent of the United Kingdom's requirements was supplied by solid fuels, while by 1972 the proportion was almost halved, with crude petroleum products filling the gap. By 1979, natural gas began increasingly to replace petroleum -- the former's share increased from less than 1 per cent in 1972 to 17.8 per cent in 1979, while growth in the latter's share had slowed considerably, and the proportion of solid fuels used had declined even further to 33.9 per cent.

Similar shifts can be seen in Germany -- from coal to petroleum to natural gas -- and in Japan where petroleum's share more than doubled between 1960 and 1979. Sweden, which did not use natural gas during the period in question, has had the greatest reliance

ble 1

ternational Comparisons of Composition of Energy Requirements[1]
lected Countries and Selected Years
illion tons of oil equivalent)

	Canada			United States			Germany			France		
	1960	1972	1979	1960	1972	1979	1960	1972	1979	1960	1972	1979
olid Fuels[2]	12.96	16.31	18.19	230.47	306.95	383.13	109.72	81.60	79.40	47.38	30.41	34.49
%	(13.5)	(9.0)	(8.4)	(22.7)	(18.2)	(20.5)	(75.3)	(32.6)	(28.0)	(52.4)	(18.6)	(17.2)
rude Petroleum & Products	40.90	82.84	91.98	452.79	766.08	866.09	31.27	140.13	143.22	26.90	107.43	119.81
%	(42.6)	(45.9)	(42.4)	(44.6)	(45.3)	(46.3)	(21.4)	(56.0)	(50.5)	(29.8)	(65.6)	(59.7)
atural Gas	9.19	34.66	45.95	294.14	539.29	482.04	.74	21.96	47.23	2.46	11.73	20.06
%	(9.6)	(19.2)	(21.2)	(29.0)	(31.9)	(25.8)	(0.5)	(8.8)	(16.6)	(2.7)	(7.2)	(10.0)
uclear, Hydro & Electricity	33.01	44.89	60.96	36.78	78.82	139.76	4.06	6.41	13.89	13.62	14.31	26.19
%	(34.4)	(24.9)	(28.1)	(3.6)	(4.7)	(7.5)	(2.8)	(2.6)	(4.9)	(15.1)	(8.7)	(13.1)
OTAL	96.05	180.50	217.08	1014.18	1691.14	1871.00	145.78	205.09	283.75	90.36	163.88	200.55
%	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)	(100.00)

	United Kingdom			Italy			Japan			Sweden		
	1960	1972	1979	1960	1972	1979	1960	1972	1979	1960	1972	1979
olid Fuels[2]	124.01	109.05	74.94	10.87	10.49	11.64	49.59	56.85	55.76	5.45	4.40	5.04
%	(73.1)	(56.4)	(33.9)	(21.8)	(8.4)	(8.1)	(52.4)	(18.2)	(14.8)	(20.0)	(9.8)	(9.7)
rude Petroleum & Products	44.01	76.26	94.32	20.47	91.22	96.92	29.93	227.01	264.55	12.58	27.72	27.55
%	(25.9)	(39.4)	(42.7)	(41.1)	(72.7)	(67.5)	(31.6)	(72.8)	(70.1)	(46.2)	(61.5)	(53.0)
atural Gas	.06	.73	41.16	5.38	12.85	23.10	.81	4.04	19.15	--	--	--
%	..	(0.4)	(18.6)	(10.8)	(10.2)	(16.1)	(0.9)	(1.3)	(5.1)			
uclear, Hydro & Electricity	1.61	7.32	10.46	13.06	10.96	11.83	14.33	23.87	38.18	9.21	12.97	19.97
%	(1.0)	(3.8)	(4.7)	(26.2)	(8.7)	(8.2)	(15.1)	(7.7)	(10.1)	(33.8)	(28.8)	(37.3)
OTAL	169.69	193.36	220.88	49.78	125.51	143.49	94.66	311.76	377.64	27.24	45.09	51.96
%	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)

Total Energy Required for intermediate inputs and final demand. Figures in brackets refer to percentage of total.

Largely coal.

ource OECD, Energy Balances of OECD Countries, 1975/1979 and earlier issues, International Energy Agency, Paris.

on various forms of electrical generation, while Canada ranks a close second.

Table 2 displays the annual average percentage change by fuel type over the 1960-1979 period. Again of interest is the shift from coal to other fuels, particularly natural gas. Italy and Japan have had the greatest increase in total energy requirements over the period, while the United Kingdom's requirements have increased by only 1.4 per cent per year. This is perhaps indicative of a shift to more efficient fuel sources over the period. However as we shall see, several other factors were undoubtedly at play.

-- Energy Requirements Per Capita

In Table 3, total energy requirements have been converted to a per capita measure -- tons of oil equivalent per person. In viewing the absolute measures, it is evident that Canada and the United States vie for top marks over the period as the greatest per capita energy users. However, it is more interesting to regard the growth in per capita energy requirements, rather than the absolute level. The United Kingdom stands alone as having very minimal growth over the period -- 1.1 per cent annual increase in per capita energy requirements. Japan has had the highest rate of growth (6.3 per cent per annum) -- perhaps a reflection of the dynamic nature of the Japanese economy over much of the period in question. However, the Italian total

Table 2

Growth of Composition of Total Energy Requirements[1] - An International Comparison, 1960-1979 (average annual percentage change)

	SOLID FUELS[2]	CRUDE PETROLEUM & PRODUCTS	NATURAL GAS	NUCLEAR HYDRO & ELECTRICITY	TOTAL
CANADA	1.8	4.4	8.8	3.3	4.4
UNITED STATES	2.7	3.5	2.6	7.3	3.3
GERMANY	-1.7	8.3	24.0	6.7	3.6
FRANCE	-1.7	8.2	11.7	3.5	4.3
UNITED KINGDOM	-2.6	4.1	41.0	10.4	1.4
ITALY	0.4	8.5	8.0	-0.5	5.7
SWEDEN	-0.4	4.2	-	4.1	3.5
JAPAN	0.6	12.2	18.1	5.3	7.6

1 Total energy required for intermediate inputs and final demand.

2 Largely coal.

Source OECD, Energy Balances of OECD Countries, International Energy Agency, various issues.

Table 3

International Comparisons of Total Energy Requirements Per Capita - Selected Years
(TOE per capita)

	1960	1966	1972	1979	1960-79 % per annum
CANADA	5.363	6.272	8.272	9.163	2.9
UNITED STATES	5.613	6.608	8.122	8.501	2.2
GERMANY	2.739	3.131	4.055	4.618	2.8
FRANCE	1.978	2.400	3.170	3.750	3.4
UNITED KINGDOM	3.241	3.548	3.855	3.953	1.1
ITALY	1.003	1.549	2.307	2.521	5.0
JAPAN	1.015	1.699	2.908	3.259	6.3
SWEDEN	3.642	4.789	5.553	6.268	2.9

Source OECD, Energy Balances of OECD Countries, 1975/1979 and earlier issues, International Energy Agency, Paris, and United Nations, Monthly Bulletin of Statistics, various issues.

energy requirements per capita also increased at a rapid annual rate of 5.0 per cent -- a point we will further reinforce when we present the development in the ratio of growth in energy requirements to growth in output.

The point still stands that Canada, along with the United States, has the highest absolute level of per capita total energy requirements of our sample countries. It should be noted, however, that the growth in these requirements, when scaled by population, is not unlike many other countries in the sample.

-- Energy Requirements per Unit of Output

As previously mentioned, total energy requirements scaled by real output growth adds yet another dimension to our comparisons. While this concept is considered an acceptable method of evaluating energy dependency, it should be remembered that the structure of the output emanating from the various countries can differ widely. For example, the Canadian economy has developed based upon a premise of inexpensive and readily available energy. The industrial structure reflects this fact. Similarly, the Swedish economy has developed centred around industries which utilize the available energy resources. For example, in Table 2 we saw that no natural gas was used in Sweden over the period. Therefore, this fuel could not be utilized as an industrial feedstock.

Table 4

Growth of Real Gross Domestic Product in Selected Countries[1]

	1960-79	1960-72	1972-79
CANADA	4.9	5.4	3.9
UNITED STATES	3.6	3.9	2.9
GERMANY	3.8	4.5	2.7
FRANCE	4.8	5.6	3.4
UNITED KINGDOM	2.5	2.7	2.0
ITALY	4.3	5.0	3.2
JAPAN	8.4	10.5	4.8
SWEDEN	3.2	3.9	1.9

1 Calculated from GDP in constant terms in national currency of country.

Source OECD, National Accounts of OECD Countries, 1950-77 and 1950-78, Volume I, and Volume II, Paris; U.N. Monthly Bulletin of Statistics, June 1981.

It is first useful to view the growth of real output, as measured by Gross Domestic Product in constant dollar terms, for our sample countries. Table 4 presents the annual rate of growth for this aggregate for the periods 1960-79, 1960-72 and 1972-79. The fragmented period clearly shows the slowdown in the mid-70s and the tremendous contrast with growth rates achieved in the sixties. As would be expected, Japan is the leader with Canada and France a distant second. The remaining countries range in rank from Italy down to the United Kingdom.

In attempting to integrate our output measure into comparisons of energy requirements, it was of interest to convert all output measures to a common volume and valuation unit. There are, admittedly, problems with such a conversion in view of the volatility of exchange rates. However, instead of using the spot average of the exchange rate for any particular year, we have converted the RDP measure from the particular country's currency using the average exchange rate over the 1973-78 period. In this way, we eliminate the choice of an atypical year for exchange rate relationships as a basis for conversion. Table 5 displays a comparison of tons of oil equivalent per million 1975 U.S. dollars of real GDP. This concept is an indication of the requirements of one input in the production process - energy - that produces a certain measure of output -- a million dollars worth of real GDP measured in 1975 prices in terms of U.S. dollars.

Table 5

Total Energy Requirements per Unit of Output (tons of oil equivalent per million U.S. dollars of real GDP)[1]

	1960	1966	1972	1979
CANADA	1260(1)	1168(1)	1256(1)	1157(1)
UNITED STATES	1088(3)	1048(3)	1142(2)	1034(2)
GERMANY	600(7)	589(7)	608(7)	571(6)
FRANCE	602(6)	565(8)	569(8)	550(8)
UNITED KINGDOM	1149(2)	1102(2)	1050(3)	937(3)
ITALY	578(8)	689(5)	797(4)	730(5)
JAPAN	641(5)	636(6)	634(6)	551(7)
SWEDEN	714(4)	743(4)	746(5)	751(4)

1 Real GDP in $1975 converted to U.S. dollars by the average exchange rate over the 1973-78 period. Ranking is presented in brackets.

Source OECD, Energy Balances of OECD Countries, 1975/1979 and Earlier Issues, International Energy Agency; OECD, National Accounts of OECD Countries, Vol. 1 1950-1978 and Vol. 2, 1950-1977; and U.N. Monthly Bulletin of Statistics, June 1981.

As in the per capita case, Canada and the United States head the field. However, they are joined in the early part of the period by the United Kingdom. The rankings between the remainder of the countries shift over time. Changes are particularly notable over the period for Japan and the United Kingdom, while Sweden and Germany's requirements per unit of output have remained fairly constant over time.

A common method of gauging the energy intensity (or efficiency) of an economy is found in a comparison of the ratios of growth in energy requirements to growth in economic activity. Table 6 presents such a measure for our set of countries for selected years over the 1960-79 period. The indexes of growth in total energy requirements (measured in MTOE), based on a 1960 = 100 base, are divided by similar indexes of growth in economic activity, in this case as measured by Gross Domestic Product in constant dollar terms in the country's domestic currency. These ratios have then been rebased to a 1970 = 1.000 base in order that we may readily observe the movements of the ratios over the period in question.

Canada's economy has become less energy intensive since 1973, at which time its ratio was close to that of the early 1970s. The ratio for the United States peaked a year earlier and the reduction has been somewhat sharper than that in Canada. However, the sharpest declines can be observed in Japan and the United Kingdom, the latter country having started from a much

Table 6

Ratio of Growth in Energy Requirements to Growth in Economic Activity
Selected Countries and Selected Years

	1960	1965	1970	1972	1973	1974	1975	1976	1977	1978	1979
CANADA	1.032	.964	1.000	1.029	1.029	1.006	.997	.957	.967	.948	.948
UNITED STATES	.943	.909	1.000	.990	.975	.965	.943	.949	.927	.920	.895
FRANCE	1.035	1.005	1.000	.978	1.032	.974	.919	.929	.912	.936	.946
GERMANY	.977	.972	1.000	.990	1.006	.976	.934	.959	.929	.923	.929
UNITED KINGDOM	1.050	1.025	1.000	.965	.931	.906	.866	.850	.859	.833	.862
ITALY	.728	.848	1.000	1.022	1.006	.976	.967	.977	.973	.940	.936
JAPAN	.957	.950	1.000	.955	.937	.952	.906	.892	.856	.829	.831
SWEDEN	.965	.984	1.000	1.008	1.028	.937	.980	1.024	1.021	1.014	1.015

Source Data derived from OECD, Energy Balances of OECD Countries, various issues and OECD, National Accounts of OECD Countries, Vol. 1, 1950-1978 and Vol. 2, 1950-1977, and the U.N. Monthly Bulletin of Statistics, recent issues.

higher ratio in 1960. Only in Sweden has there been an increase in the measure in the period since the post-OPEC period and this can be traced to the phenomenum of strong growth in energy requirements in the 1975-77 period with GDP growth close to negative over the three year period.

It is interesting to note the rapid increase in the Italian ratio during the 1960s -- from .728 in 1960 to the base 1.000 in 1970. Italy's energy requirements grew by 135.5 per cent during the decade, far outstripping growth in economic activity of 71.4 per cent. Despite this fact, if one refers to our other comparisons of energy use measures it is evident that Italy, for a variety of reasons, is the lowest energy user among our sample.

Chart 1 presents the ranking of our three energy requirement measures -- total energy requirements, total energy requirements per capita, and total energy requirements per unit of output. It can be clearly observed that scaling the measures by population or output changes the ranking and presents a very different picture of our sample countries' positions relative to one another. Changes within the rankings for the overseas countries over time are notable -- particularly those for Japan and the United Kingdom. While Canada's energy requirements in absolute terms rank mid-way in our set, the country's low population density and energy intensive industrial base jettison it to the top of the set.

Chart 1

Ranking of Energy Requirement Measures, Selected Countries and Selected Years

A: TOTAL ENERGY REQUIREMENTS

1960	1966	1972	1979
United States	United States	United States	United States
United Kingdom	United Kingdom	Japan	Japan
Germany	Germany	Germany	Germany
Canada	Japan	United Kingdom	United Kingdom
Japan	Canada	Canada	Canada
France	France	France	France
Italy	Italy	Italy	Italy
Sweden	Sweden	Sweden	Sweden

B: TOTAL ENERGY REQUIREMENTS PER CAPITA

1960	1966	1972	1979
United States	United States	Canada	Canada
Canada	Canada	United States	United States
Sweden	Sweden	Sweden	Sweden
United Kingdom	United Kingdom	Germany	Germany
Germany	Germany	United Kingdom	United Kingdom
France	France	France	France
Japan	Japan	Japan	Japan
Italy	Italy	Italy	Italy

C: TOTAL ENERGY REQUIREMENTS PER UNIT OF OUTPUT

1960	1966	1972	1979
Canada	Canada	Canada	Canada
United States	United States	United States	United States
United Kingdom	United Kingdom	United Kingdom	United Kingdom
Japan	Sweden	Sweden	Sweden
Sweden	Japan	Italy	Italy
Germany	Italy	Japan	Germany
France	Germany	Germany	Japan
Italy	France	France	France

Many other interesting points can be drawn from these tables. For the most recent time period considered, 1979, the United States requires the greatest absolute amount of energy, while Canada has the greatest per capita requirements. The annualized growth in Japan's energy requirements during the period in question exceeds all others, and is more than double that of the United States.

III The Importance of the Transformation Sector

In our comparisons to this point we have used a measure dealing with the concept of total energy requirements in the economy. As detailed before, this concept measures energy inputs of all types that satisfy fuel requirements for intermediate use and for final energy consumption. In this section we are interested in the segment of total energy requirements that fulfill requirements for intermediate use -- in other words, the transformation sector. In essence, this sector is defined in our work as the difference between total energy requirements and final energy consumption. It includes energy required for the generation and production of energy forms, losses incurred in the generation, transportation and conversion of such energy production processes, plus a very small category which is labelled by the OECD "statistical differences".

It follows from this description that a country which generates a large proportion of its own energy requirements, rather than

importing them from another country, would probably have a larger transformation sector. It also follows that the size of the transformation sector would be proportionate to the degree of further processing required for imported supplies in energy-importing countries.

In Table 7, we have displayed the transformation sector of our various countries as a per cent of total energy requirements. It has been suggested that the Canadian transformation sector is particularly large relative to that of other countries, thus perhaps biasing comparisons made using total energy requirements. The Canadian sector is indeed large as is Sweden's of late, particularly in comparison to the U.S. and Italian sectors. As noted before, the former two countries rely more extensively on energy based on electrical generation.

What is interesting is the evolution of the size of these sectors over time. In 1960, the Japanese transformation sector accounted for 35.3 per cent of total energy requirements. In that year 61.5 per cent of Japan's total energy requirements came from indigenous sources, particularly from solid fuel sources, of which some 40 per cent went to the generation of other fuel sources. By 1979, only 27.2 per cent of Japan's total energy requirements was used in the transformation sector. In that year only 14.3 per cent of Japanese energy requirements was indigenously produced. The country had moved to extensive reliance on crude petroleum, the transformation requirements of

Table 7

Transformation Sector as Per Cent of Total Energy Requirements - An International Comparison, Selected Years

	1960	1966	1972	1979
CANADA	34.7	31.5	30.1	32.2
UNITED STATES	20.1	22.5	22.1	27.7
GERMANY	29.9	24.1	24.0	25.3
FRANCE	29.8	26.6	22.7	22.4
UNITED KINGDOM	27.7	31.3	31.9	30.5
ITALY	27.2	20.7	20.7	23.5
SWEDEN	31.2	29.1	24.9	33.7
JAPAN	35.3	27.1	27.3	27.2

Source OECD, Energy Balances of OECD Countries, International Energy Agency, 1975/1979.

which are less energy intensive than other fuel forms such as electrical generation.

IV Comparisons of Energy Consumption

We have seen that final energy consumption represents a differing proportion of total energy requirements within our set of countries. Before we move to an analysis of consumption by sectors of the economy, it is of interest to reconsider our comparisons of energy requirements per capita and per unit of output for the eight countries in terms of final energy consumption. A clear linkage has been established between the level of output and the amount of energy required to produce that output. It was formerly regarded that this linkage was relatively immutable, however since the events of 1973-74 it has clearly emerged that this linkage is more elastic than was previously thought. Table 6 substantiated this fact.

Similarly, there is a linkage between energy requirements and level of per capita income. It is postulated that the income level is directly related to the level of energy consumption -- higher income countries consuming more energy. We have established before that final energy consumption is measured as "...the sum of consumption by the different end use sectors and should also be equal to total energy requirements (TER) less transformation and distribution losses."[2]

-- Final Energy Consumption

Table 8 displays final energy consumption for our set of countries measured in million tons of oil equivalent. Again, the United States has consumed the greatest amount of energy in absolute terms. However, of much greater interest is the change over time in the levels of consumption. As before, the United Kingdom exhibits the lowest rate of change over the period -- 1.3 per cent, or a level that is only 26.6 per cent higher in 1979 than it was in 1960. At the opposite extreme is Japan, whose consumption has increased by 340 per cent over the period, an annual rate of growth of 8.1 per cent.

Canada's ranking is fourth in terms of the rate of growth over the period when regarding absolute levels of final energy consumption. However, the rate of growth of total Canadian consumption has diminished since 1972 from a rate of growth of 5.9 per cent per annum to one of 1.8 per cent. This type of slowdown in the rate of consumption is evident in the majority of countries in our sample.

-- Final Energy Consumption Per Capita

A comparison of final energy consumption per capita is presented in Table 9. United States tops the ranking in this comparison, closely followed by Canada in every year analyzed. In per capita terms, Japan had the lowest level of consumption in

Table 8

International Comparison of Final Energy Consumption
(millions tons of oil equivalent)

	1960	1966	1972	1979	1960-79 % pa
CANADA	59.72	81.49	119.71	135.67	4.4
UNITED STATES	772.55	965.43	1246.46	1284.40	2.7
GERMANY	98.90	128.15	171.03	203.40	3.9
FRANCE	61.10	82.60	116.61	149.84	4.8
UNITED KINGDOM	118.31	125.80	136.08	149.88	1.3
ITALY	34.25	56.57	89.13	107.66	6.2
JAPAN	59.46	106.94	207.68	261.52	8.1
SWEDEN	17.93	25.68	31.64	33.50	3.3

Source OECD, Energy Balances of OECD Countries, 1975/1979 and Earlier Issues, International Energy Agency.

Table 9

International Comparison of Final Energy Consumption Per Capita
(TOE per capita)

	1960	1966	1972	1979	1960-79 % pa
CANADA	3.334	4.064	5.486	5.727	2.9
UNITED STATES	4.276	4.912	5.986	5.836	1.7
GERMANY	1.858	2.147	2.773	3.311	3.1
FRANCE	1.338	1.680	2.256	2.802	4.0
UNITED KINGDOM	2.260	2.308	2.439	2.682	0.9
ITALY	.690	1.081	1.638	1.892	5.5
JAPAN	.638	1.072	1.937	2.257	6.9
SWEDEN	2.397	3.288	3.897	4.041	2.8

Source OECD, Energy Balances of OECD Countries, 1975/1979 and Earlier Issues, International Energy Agency; and Monthly Bulletin of Statistics, United Nations Publication, Various Issues.

1960. By 1979 Italy had claimed this position. In terms of the Canadian experience over time, it is interesting to note that three countries, Canada, Germany and Sweden, had very similar rates of growth in consumption per capita over the period.

Only one country -- the United States -- experienced a decline in per capita terms during the 1960-79 period, and most of that decline actually took place between 1973 and 1974. Chart 2 illustrates the trends in energy consumption per capita for our set of countries. In this chart the figures for tons of oil equivalent per capita have been indexed on a 1970 = 1.00 base.

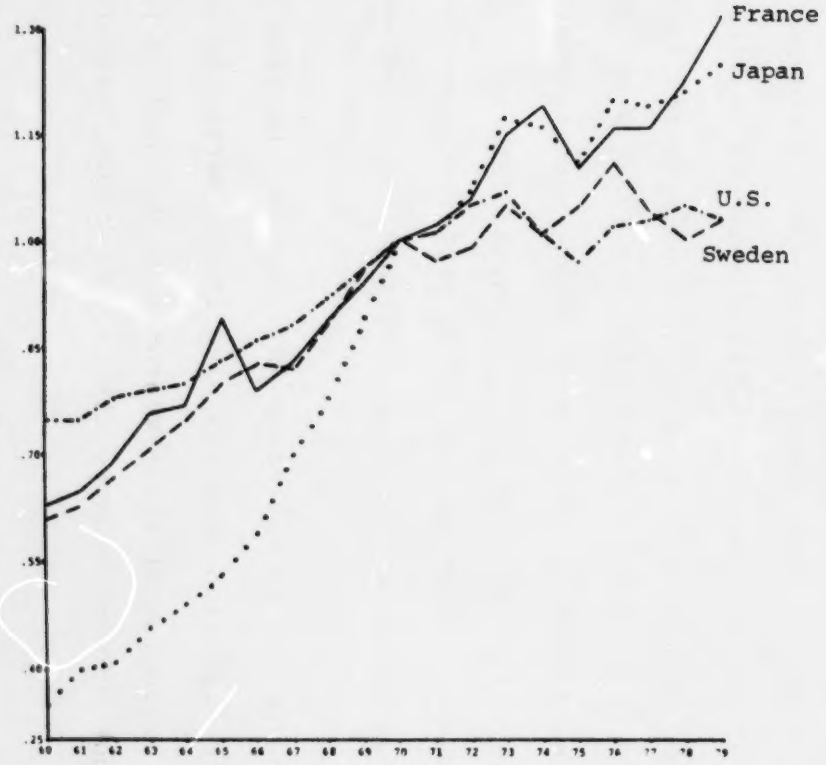
-- Final Energy Consumption Per Unit of Output

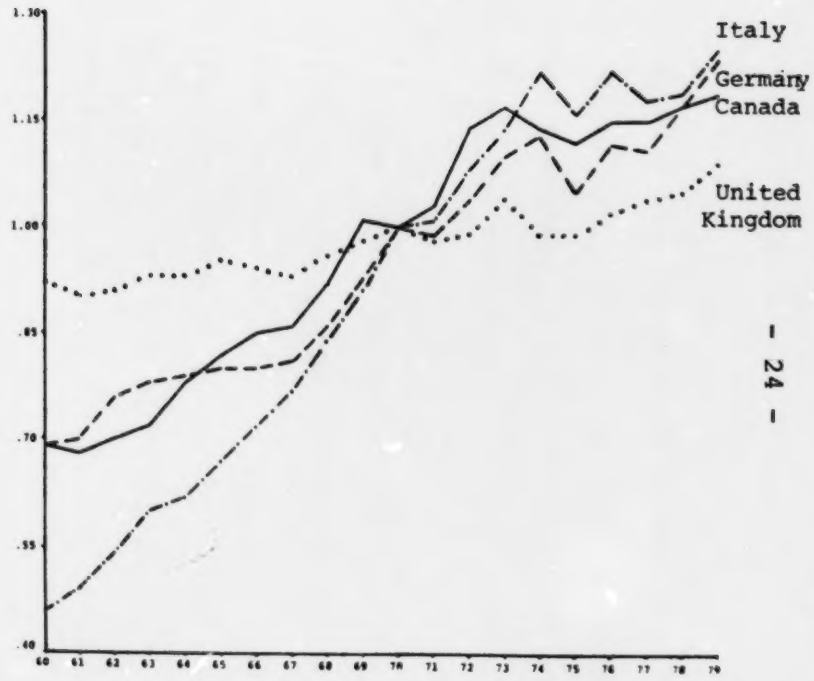
To make our last comparison of final energy consumption, it is scaled by real domestic product measured in 1975 U.S. dollars. Again, we have converted the output measures from national currency to U.S. dollars using the 1973-78 average annual spot exchange rate in order to at least partially eliminate estimation errors caused by exchange rate volatility. Table 10 displays a comparison of final energy consumption per unit of output for selected years over the 1960-79 period.

The period in the early 1970s around the time of the first OPEC price explosion seems to have indeed marked a turning point in the evolution of these measures of consumption per unit of output. Every country within our sample, except France,

Chart 2

Final Energy Consumption Per Capita, 1960-1979
Selected Countries (TOE per person)





Source OECD, Energy Balances of OECD Countries, 1975/1979 and earlier issues, International Energy Agency; and Monthly Bulletin of Statistics, United Nations Publication, various issues.

Table 10

International Comparison of Final Energy Consumption per Unit of Output
(TOE per million dollars of GDP)[1]

	1960	1966	1972	1979
CANADA	783.4	757.1	833.3	723.3
UNITED STATES	828.6	779.3	841.6	709.9
GERMANY	407.2	404.2	415.7	409.0
FRANCE	407.0	395.2	404.8	411.2
UNITED KINGDOM	800.9	716.8	664.1	635.7
ITALY	397.7	481.0	566.3	547.8
JAPAN	402.7	401.4	422.0	381.9
SWEDEN	470.3	510.4	523.3	484.3

1 Real GDP in $1975 converted to U.S. dollars by the average exchange rate over the 1973-78 period.

Source OECD, Energy Balances of OECD Countries, 1975/1979 and Earlier Issues, International Energy Agency; OECD, National Accounts of OECD Countries, Vol. 1, 1950-1978, and U.N. Monthly Bulletin of Statistics, recent issues.

witnessed a downturn of some magnitude between the 1972 and 1979. Of particular interest is the size of the decline in the case of the United States and Canada.

In Table 11 we present energy intensity ratios based upon consumption, rather than upon our previous measure of total energy requirements. Indices of final energy consumption have been divided by indices of real domestic product measured in domestic currencies at 1975 prices. These energy intensity ratios based on consumption present a very different picture in the case of some of the countries in our set than that presented by ratios using total energy requirements.

Canada's performance, as measured by this concept, shows a declining ratio from 1972 forward, with a levelling during the 1977-1979 period. The ratios for the United Kingdom and Italy present opposing trends. As was evident in our previous comparisons, the United Kingdom shows a marked reduction in energy intensity over the 1960-1973 period. This reduction is particularly apparent in the industrial sector where over this period energy consumption increased by only 20 per cent, while total output increased by 50 per cent. This phenomenum is related to the U.K. shift from coal to petroleum and natural gas in this sector. In Italy, we see a growing energy intensity ratio. The growth in consumption is centered in the industrial and road transportation sectors.

Table 11

Ratio of Growth in Energy Consumption to Growth in Economic Activity
Selected Countries and Selected Years

	1960	1965	1970	1972	1973	1974	1975	1976	1977	1978	1979
CANADA	.970	.951	1.000	1.032	.995	.949	.931	.916	.904	.900	.895
UNITED STATES	.973	.925	1.000	.988	.956	.925	.902	.909	.883	.863	.833
FRANCE	.975	.986	1.000	.970	1.002	1.013	.938	.948	.927	.947	.985
GERMANY	.962	.965	1.000	.982	1.000	1.019	.968	.968	.939	.951	.967
UNITED KINGDOM	1.143	1.042	1.000	.953	.927	.897	.903	.895	.903	.887	.913
ITALY	.724	.859	1.000	1.049	1.038	1.082	1.075	1.071	1.023	1.013	1.014
JAPAN	.914	.900	1.000	.967	.971	.984	.938	.960	.916	.889	.876
SWEDEN	.884	.930	1.000	.984	1.012	.941	.974	1.016	.985	.921	.911

Source Data derived from OECD, Energy Balances of OECD Countries, various issues; OECD, National Accounts of OECD Countries, Vol. 1, 1950-1978 and Vol. 2, 1950-1977, and U.N. Monthly Bulletin of Statistics, recent issues.

-- Final Energy Consumption by Sector

Previously we have considered total final energy consumption for all sectors of the economy. As indicated above, it is useful to view those patterns of consumption for our eight countries by a more disaggregated view of the sectors within the economy. We have segregated three major sectors: industrial, with iron and steel broken out; transportation, with road consumption isolated; and a residual, other sectors, out of which we can isolate residential use for the 1975-79 period only.

Table 12 presents the distribution by sector of final energy consumption for our set of countries for three selected years within the period in question. Growth rates for the 1960-79 period by country and by sector are illustrated in Table 13.

In Canada, by 1979, consumption is divided fairly evenly amongst the three sectors with the strongest growth evident in the transportation sector. Canadian growth in total consumption is midway in our sample, a much slower rate of growth than in Italy or Japan.

The United States is a fairly similar case: consumption in each of the three sectors ranges between 30 to 35 per cent over the period. Again, the transportation sector has undergone fairly strong growth, although not nearly as strong as in Canada. Industrial, geographic and climatic factors dictate many North

Table 12

Distribution by Sector of Final Energy Consumption
Selected Countries and Selected Years[1]

(million tons of oil equivalent)

	Canada			United States			Germany			France		
	1960	1972	1979	1960	1972	1979	1960	1972	1979	1960	1972	1979
Total	59.72	119.71	135.67	772.55	1246.46	1284.40	98.90	171.03	203.40	61.10	116.61	149.84
%	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(49.1)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
Industrial	21.37	40.96	41.51	272.20	420.81	403.61	48.53	68.68	76.21	29.12	46.27	60.50
%	(35.8)	(34.2)	(30.6)	(35.2)	(33.8)	(31.4)	(49.1)	(40.2)	(37.5)	(47.7)	(39.7)	(40.4)
- Iron & Steel	2.51	4.59	6.72	52.08	57.04	63.22	19.01	22.46	20.65	10.20	12.63	12.06
%	(4.2)	(3.8)	(5.0)	(6.7)	(4.6)	(4.9)	(19.2)	(13.1)	(10.2)	(16.7)	(10.8)	(8.0)
Transportation	16.01	30.65	42.78	234.26	387.27	459.72	15.84	31.94	39.02	11.64	24.80	34.34
%	(26.8)	(25.6)	(31.5)	(30.3)	(31.1)	(35.8)	(16.0)	(18.7)	(19.2)	(19.1)	(21.3)	(22.9)
- Road	13.00	25.61	34.01	194.54	318.04	390.19	8.87	26.42	33.89	6.92	20.99	29.66
%	(21.8)	(21.4)	(25.1)	(25.2)	(25.5)	(30.4)	(9.0)	(15.4)	(16.7)	(11.3)	(18.00)	(19.8)
Other Sectors	22.34	48.10	51.38	266.09	438.38	421.08	34.54	70.41	88.18	20.34	45.54	54.99
%	(37.4)	(40.2)	(37.9)	(34.4)	(35.2)	(32.8)	(34.9)	(41.2)	(43.4)	(33.3)	(39.1)	(36.7)
- Residential	NA	NA	28.62	NA	NA	309.83	NA	NA	58.56	NA	NA	43.50
%			(21.1)			(24.1)			(28.8)			(29.0)

	United Kingdom			Italy			Japan			Sweden		
	1960	1972	1979	1960	1972	1979	1960	1972	1979	1960	1972	1979
Total	118.31	136.08	149.88	34.25	89.13	107.66	59.46	106.94	261.52	17.93	31.64	33.50
%	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)	(100.0)
Industrial	48.28	54.95	56.87	17.29	40.15	47.82	36.55	61.01	145.70	8.70	13.12	14.13
%	(40.8)	(40.4)	(37.9)	(50.5)	(45.0)	(44.4)	(61.5)	(57.1)	(55.7)	(48.5)	(41.5)	(42.2)
- Iron & Steel	16.18	14.15	10.96	3.31	7.92	8.44	10.34	22.00	41.50	1.66	2.32	2.21
%	(13.7)	(10.4)	(7.3)	(9.7)	(8.9)	(7.8)	(17.4)	(20.6)	(15.9)	(9.3)	(7.3)	(6.6)
Transportation	21.11	28.95	33.62	6.78	18.50	24.62	11.73	20.23	53.92	2.87	5.06	6.17
%	(17.8)	(21.3)	(22.4)	(19.8)	(20.8)	(22.9)	(19.7)	(19.9)	(20.6)	(16.0)	(16.0)	(18.4)
- Road	10.98	22.37	26.15	4.83	15.66	21.91	5.46	13.36	36.65	2.00	3.94	5.24
%	(9.3)	(16.4)	(17.4)	(14.1)	(17.6)	(20.4)	(9.2)	(12.49)	(14.0)	(11.2)	(12.4)	(15.6)
Other Sectors	48.92	52.18	59.39	10.18	30.48	35.23	11.18	25.69	61.90	6.36	13.46	13.20
%	(41.3)	(38.3)	(39.6)	(29.7)	(34.2)	(32.7)	(18.8)	(24.0)	(23.7)	(35.5)	(42.5)	(39.4)
- Residential	NA	NA	39.17	NA	NA	31.22	NA	NA	52.03	NA	NA	11.00
%			(26.1)			(29.0)			(19.9)			(32.8)

1 Figures in brackets refer to percentage of total.

Source OECD, Energy Balances of OECD Countries, 1975/1979 and earlier issues, International Energy Agency, Paris.

Table 13

Growth of Energy Consumption by Sector[1] - An International Comparison, 1960-1979
(average annual per cent change in million tons of oil equivalent)

	Industrial		Transportation		Other[2] Sectors	Total Consumption
	Total	Iron & Steel	Total	Road		
CANADA	3.6	5.3	5.3	5.2	4.5	4.4
UNITED STATES	2.1	1.0	3.6	3.7	2.4	2.7
GERMANY	2.4	0.4	4.9	7.3	5.1	3.9
UNITED KINGDOM	0.9	-2.0	2.5	4.7	1.0	1.3
ITALY	5.5	5.0	7.0	8.3	6.8	6.2
SWEDEN	2.6	1.5	4.1	5.2	3.9	3.3
JAPAN	7.5	7.5	8.4	10.5	9.4	8.1
FRANCE	3.9	0.9	5.9	8.0	5.4	4.8

1 Final energy consumption, i.e., domestic consumption less the sum of quantities transformed and own use by the energy sector.

2 The largest component of this sector is residential demand but it cannot be broken out since the comparable data is available only from 1975.

Source OECD, Energy Balances of OECD Countries, 1975/1979, International Energy Agency, Paris.

American similarities. However, these factors become less relevant for other countries in our sample.

The industrial sector of the Japanese economy consumes well over half of its energy requirements. This sector's thirst for energy has declined somewhat over the period. The transportation sector takes a poor third, as might be expected considering the efficiency of the autos, the geography of the country and the population density. However, road transportation's share has increased by 50 per cent over the period, hence implying a considerable reduction in fuel usage in other segments of the transportation sector. This fact is substantiated in Table 13.

A similar situation exists in Italy where transportation consumes little over 20 per cent -- with similar factors at play. Italian industrial usage constitutes close to 50 per cent of total consumption in the early part of the period, falling to 44.4 per cent by 1979. Part of the decline in industrial use is attributable to a reduction in the iron and steel industry's consumption.

The sectoral composition in France, Germany and the United Kingdom is quite similar. Striking in all three cases is the considerable reduction in the share of the iron and steel industry's consumption. This possibly stems from a combination of factors such as more energy-efficient methods of production with a switch to more efficient fuel sources, plus some reduction

in levels of crude steel output. Sweden is a similar case. The transportation sector uses around a sixth of energy consumed in the country -- the remainder is evenly divided between the industrial and commercial and residential sectors.

Before moving to a discussion of trends in the sectoral distribution of energy consumption within the various economies, it is of interest to again present our comparison of rankings as displayed for total energy requirements in Chart 1. This time in Chart 3, we use final energy consumption as the measure of energy use. Because of the size of the energy transformation and distribution sector in the Canadian economy, we see a very different set of rankings. The United States remains at the head of the set throughout the majority of the period in Chart 3. In per capita terms, Canada retains second place, while in energy per unit of output this country moves to second ranking by 1966 and retains that position until 1979 when she takes the lead with the United States a close second.

-- Sectoral Breakdown of Consumption by Energy Source

Table 14 displays a sectoral breakdown of Canadian energy consumption by fuel source for selected years during our sample period, 1960, 1970 and 1978. This table attempts to shed light on the questions such as "Within the Canadian industrial sector, which fuel source is dominant, and has that dominance changed over the period under consideration?" From it, we can clearly see

Chart 3

Ranking of Final Energy Consumption Measures, Selected Countries and Selected Years

A: FINAL ENERGY CONSUMPTION

1960	1966	1972	1979
United States	United States	United States	United States
United Kingdom	Germany	Japan	Japan
Germany	United Kingdom	Germany	Germany
France	Japan	United Kingdom	United Kingdom
Canada	France	Canada	France
Japan	Canada	France	Canada
Italy	Italy	Italy	Italy
Sweden	Sweden	Sweden	Sweden

B: FINAL ENERGY CONSUMPTION PER CAPITA

1960	1966	1972	1979
United States	United States	United States	United States
Canada	Canada	Canada	Canada
Sweden	Sweden	Sweden	Sweden
United Kingdom	United Kingdom	Germany	Germany
Germany	Germany	United Kingdom	France
France	France	France	United Kingdom
Italy	Italy	Japan	Japan
Japan	Japan	Italy	Italy

C: FINAL ENERGY CONSUMPTION PER UNIT OF OUTPUT

1960	1966	1972	1979
United States	United States	United States	Canada
United Kingdom	Canada	Canada	United States
Canada	United Kingdom	United Kingdom	United Kingdom
Sweden	Sweden	Italy	Italy
Germany	Italy	Sweden	Sweden
France	Germany	Japan	France
Japan	Japan	Germany	Germany
Italy	France	France	Japan

Table 14

Canada

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	0.03 (..)	- (--)	15.67 (47)	0.31 (3)	16.01 (27)
IRON & STEEL	0.22 (3)	0.10 (1)	- (--)	2.19 (20)	2.51 (4)
OTHER INDUSTRIAL	5.27 (63)	3.17 (45)	5.01 (15)	5.40 (50)	18.86 (32)
OTHER SECTORS[2]	2.84 (34)	3.77 (54)	12.81 (38)	2.92 (27)	22.34 (37)
TOTAL	8.36 (100)	7.04 (100)	33.49 (100)	10.82 (100)	59.72 (100)
1970					
TRANSPORTATION	0.04 (..)	- (--)	27.37 (46)	0.05 (..)	27.47 (27)
IRON & STEEL	0.46 (3)	0.64 (3)	0.77 (1)	2.64 (39)	4.51 (4)
OTHER INDUSTRIAL	7.67 (49)	9.49 (47)	9.59 (16)	3.50 (52)	30.24 (30)
OTHER SECTORS	7.52 (48)	10.00 (50)	22.18 (37)	0.59 (9)	40.29 (39)
TOTAL	15.69 (100)	20.13 (100)	59.91 (100)	6.78 (100)	102.51 (100)
1978					
TRANSPORTATION	- (--)	- (--)	40.68 (57)	0.02 (..)	40.70 (31)
IRON & STEEL	0.61 (3)	1.42 (4)	0.46 (1)	2.64 (49)	5.12 (4)
OTHER INDUSTRIAL	9.64 (40)	14.98 (48)	11.08 (15)	2.54 (48)	38.25 (29)
OTHER SECTORS	13.85 (57)	14.90 (48)	19.35 (27)	0.15 (3)	48.26 (36)
TOTAL	24.10 (100)	31.30 (100)	71.57 (100)	5.35 (100)	132.33 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and others.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

the increasing dependence on natural gas over the period, particularly within the commercial and residential sector. Also evident is the almost total dependence of the transportation sector on petroleum products and the strong growth in consumption in this sector. The role of coal and other solid fuels has diminished over the period, while that of nuclear and hydro has increased, a fact that is particularly evident in the residential and commercial sectors.

In a similar fashion, we can explore the sectoral distribution by energy source for other countries in our sample.

Table 15 presents the evolution of the sectoral breakdown by energy source for the United States over the 1960-1978 period. Interesting shifts and cycles are visible in this table. For example, in 1960, 74 per cent of coal in the United States was consumed by the industrial sector, while 25 per cent was used by the commercial and residential sector. Coal consumption in absolute terms declined and then began to increase over the 70s; by 1978 over 74 million tons oil equivalent, or 94 per cent of total coal consumption was found in the industrial sector. This represented an increase over the 1960 level. The decline in total sectoral consumption over the period was due to the reduction in consumption by the commercial and residential sectors.

Table 15

United States

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	.47 (1)	- (--)	232.43 (58)	1.36 (1)	234.26 (30)
IRON & STEEL	4.30 (6)	7.68 (4)	- (--)	40.10 (41)	52.08 (7)
OTHER INDUSTRIAL	31.36 (47)	99.48 (48)	56.95 (14)	32.33 (33)	220.12 (29)
OTHER SECTORS[2]	30.56 (46)	100.35 (48)	110.46 (28)	24.72 (25)	266.09 (34)
TOTAL	66.69 (100)	207.51 (100)	399.84 (100)	98.51 (100)	772.55 (100)
1970					
TRANSPORTATION	.40 (..)	- (--)	347.72 (59)	0.44 (1)	348.55 (30)
IRON & STEEL	4.26 (4)	13.72 (4)	4.61 (1)	31.48 (42)	54.07 (5)
OTHER INDUSTRIAL	55.62 (43)	181.30 (49)	76.58 (13)	33.40 (44)	346.89 (30)
OTHER SECTORS	68.66 (53)	174.78 (47)	156.49 (27)	9.66 (13)	409.60 (35)
TOTAL	128.94 (100)	369.80 (100)	585.40 (100)	74.98 (100)	1159.11 (100)
1978					
TRANSPORTATION	0.30 (..)	- (--)	466.17 (64)	0.01 (..)	466.47 (36)
IRON & STEEL	7.73 (5)	11.09 (3)	5.07 (1)	37.96 (47)	61.85 (5)
OTHER INDUSTRIAL	62.30 (35)	123.28 (39)	98.45 (13)	37.36 (47)	321.39 (24)
OTHER SECTORS	105.62 (60)	184.77 (58)	156.72 (22)	4.59 (6)	451.69 (35)
TOTAL	175.95 (100)	319.14 (100)	726.41 (100)	79.92 (100)	1301.40 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and others.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

Interesting patterns are also visible within natural gas consumption where there has been an absolute decline over the 1970-78 period. This reduction in consumption was centered in the industrial sector and indicates substitution to other fuels plus perhaps some increase in efficiency. The only sector exhibiting continued growth in natural gas consumption is the commercial and residential sector. Despite the controversy in the country concerning the use of nuclear power, a close examination of the consumption figures for nuclear and hydro power indicates a considerable increase over the period in nuclear power generation, particularly over the 1970-78 period. As in the case of Canada, the dependence of the transportation sector on petroleum products is clearly visible in this table.

Unlike the North American countries, France (Table 16) showed a fair dependence on coal in the transportation sector in the early sixties. Coal consumption over the period in question has decreased rapidly, and it has been in the residential and commercial sectors where the substitution to other fuels, particularly gas and electricity, is apparent. Growth in gas consumption has outstripped electricity with the greatest substitutions made in the industrial sector, excluding iron and steel production.[3] It is in the iron and steel sector where considerable conservation is shown. This can be attributed, in part, to efficiency factors but there has also been a reduction in production over the period.[4]

Table 16

France

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	.30 (6)	.06 (3)	8.90 (43)	2.38 (7)	11.64 (19)
IRON & STEEL	.64 (12)	-1.01 (-53)	.76 (4)	9.81 (29)	10.20 (17)
OTHER INDUSTRIAL	2.92 (56)	1.60 (85)	5.59 (27)	8.81 (26)	18.92 (31)
OTHER SECTORS[2]	1.33 (26)	1.23 (65)	5.26 (26)	12.52 (38)	20.34 (33)
TOTAL	5.19 (100)	1.88 (100)	20.51 (100)	33.52 (100)	61.10 (100)
1970					
TRANSPORTATION	.50 (5)	.02 (..)	20.46 (30)	.28 (1)	21.25 (20)
IRON & STEEL	1.01 (9)	.27 (4)	2.11 (3)	10.30 (44)	13.69 (13)
OTHER INDUSTRIAL	5.30 (50)	3.38 (49)	23.20 (35)	4.26 (18)	36.14 (33)
OTHER SECTORS	3.79 (36)	3.28 (47)	21.11 (32)	8.44 (36)	36.62 (34)
TOTAL	10.60 (100)	6.95 (100)	66.88 (100)	23.28 (100)	107.70 (100)
1978					
TRANSPORTATION	.57 (3)	- (--)	30.95 (34)	.03 (..)	31.55 (23)
IRON & STEEL	1.27 (8)	1.28 (7)	1.88 (2)	7.45 (55)	11.88 (8)
OTHER INDUSTRIAL	6.63 (39)	7.67 (44)	26.33 (28)	1.86 (14)	42.48 (30)
OTHER SECTORS	8.56 (50)	8.58 (49)	33.08 (36)	4.15 (31)	54.37 (39)
TOTAL	17.03 (100)	17.53 (100)	92.24 (100)	13.49 100)	140.28 (100)

1 Figures in brackets indicate percentages within groups.

2 Residential, commercial and others.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

In Germany, as shown in Table 17, 41 per cent of petroleum consumption was accounted for by the transportation sector. By 1978, the residential and commercial sectors' share of petroleum consumption had increased from 28 to 43 per cent. We again see a shift towards a considerable degree of dependence on petroleum products in the transportation sector over the period, however, the overall growth in consumption has been slower in this sector than in others -- a reflection of the economies of low gasoline consumption automobiles. The decline in iron and steel sector energy consumption is centred mainly in decreased coal consumption. The shift from coal to natural gas and electricity, as well as to petroleum, in all sectors other than transportation over the 1960-78 period is very evident, although it was more marked during the first part of the period.

The United Kingdom (Table 18) presents an interesting case which harkens back to our earlier discussion. This was the country in our sample which showed the most dramatic reduction in the growth of energy requirements, no matter which measure was used. This decrease in consumption can be clearly seen when regarding the iron and steel and other industrial sectors. In part this outcome is indicative of the troubled U.K. economy over the 70s, however we should remember that when measured on an energy consumption per unit of output basis, a substantial decline was noticed.

Table 17

Germany

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	0.33 (4)	- (--)	10.03 (41)	5.48 (8)	15.84 (16)
IRON & STEEL	1.01 (12)	-3.79 (-256)	1.24 (5)	20.55 (32)	19.01 (19)
OTHER INDUSTRIAL	4.64 (56)	3.62 (245)	6.20 (26)	15.05 (23)	29.52 (30)
OTHER SECTORS[2]	2.32 (28)	1.65 (111)	6.84 (28)	23.73 (37)	34.54 (35)
TOTAL	8.30 (100)	1.48 (100)	24.31 (100)	64.81 (100)	98.91 (100)
1970					
TRANSPORTATION	0.68 (4)	- (--)	26.50 (29)	0.70 (2)	27.88 (17)
IRON & STEEL	1.73 (10)	-.47 (-4)	3.69 (4)	17.60 (43)	22.55 (14)
OTHER INDUSTRIAL	8.18 (46)	7.22 (65)	22.62 (24)	7.11 (17)	45.14 (28)
OTHER SECTORS	7.15 (40)	4.32 (39)	39.76 (43)	15.90 (38)	67.13 (41)
TOTAL	17.74 (100)	11.07 (100)	92.57 (100)	41.31 (100)	162.70 (100)
1978					
TRANSPORTATION	.82 (3)	- (--)	37.00 (32)	.12 (1)	37.94 (20)
IRON & STEEL	2.02 (8)	4.85 (17)	2.57 (2)	10.97 (55)	20.41 (10)
OTHER INDUSTRIAL	10.36 (39)	11.57 (39)	27.24 (23)	4.11 (20)	53.28 (28)
OTHER SECTORS	13.04 (50)	13.06 (44)	49.89 (43)	4.90 (24)	80.89 (42)
TOTAL	26.24 (100)	29.48 (100)	116.70 (100)	20.10 (100)	192.52 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and others.

Source Energy Balances of OECD Countries 1974/78, International Energy Agency.

Table 18

United Kingdom

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	.20 (2)	- (--)	14.17 (48)	6.74 (9)	21.11 (18)
IRON & STEEL	.82 (9)	.33 (5)	2.30 (8)	12.73 (17)	16.18 (14)
OTHER INDUSTRIAL	3.84 (41)	1.66 (27)	7.06 (24)	19.54 (27)	32.10 (27)
OTHER SECTORS[2]	4.57 (48)	4.09 (67)	5.74 (20)	34.52 (47)	48.92 (41)
TOTAL	9.43 (100)	6.08 (100)	29.27 (100)	73.53 (100)	118.31 (100)
1970					
TRANSPORTATION	.24 (1)	- (--)	26.37 (41)	.20 (1)	26.81 (20)
IRON & STEEL	1.17 (7)	.56 (4)	5.27 (8)	9.33 (22)	16.33 (12)
OTHER INDUSTRIAL	5.96 (34)	2.71 (21)	20.45 (32)	10.72 (26)	39.84 (29)
OTHER SECTORS	10.19 (58)	9.94 (75)	11.79 (19)	21.23 (51)	53.15 (39)
TOTAL	17.56 (100)	13.21 (100)	63.88 (100)	41.48 (100)	136.13 (100)
1978					
TRANSPORTATION	.25 (1)	- (--)	32.56 (47)	0.05 (··)	32.86 (23)
IRON & STEEL	1.14 (6)	1.01 (3)	2.48 (3)	5.33 (27)	9.96 (6)
OTHER INDUSTRIAL	6.89 (34)	12.63 (37)	21.88 (32)	4.28 (21)	45.68 (32)
OTHER SECTORS	12.07 (59)	20.78 (60)	12.39 (18)	10.54 (52)	55.78 (39)
TOTAL	20.35 (100)	34.42 (100)	69.31 (100)	20.20 (100)	144.28 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and other.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

In 1960, over 30 per cent of energy consumption for the transportation sector was supplied by coal. Moreover, 70 per cent of commercial and residential requirements were fulfilled by coal. By 1978, less than 1 per cent of transportation consumption was coal supplied, and only 19 per cent of commercial and residential consumption arose from coal. The shift was dramatic, and was first to petroleum, and then later to natural gas reflecting the availability of North Sea gas. This increased natural gas consumption is particularly evident in the commercial and residential sectors.

The Italian case is again different. In this country we saw a dramatic increase in the energy intensity ratio over the 1960-1970 period. The shifts that we see in Table 19 to a large extent reflect the nature of the Italian economy. Over the first decade petroleum product consumption in all sectors, except that of iron and steel, increased dramatically. This was particularly evident in the commercial and residential sector and did not necessarily indicate a huge substitution from other fuel forms.

In the iron and steel sector, coal has continued to supply close to 50 per cent of the requirements over the whole period. There has been no marked reduction in this figure, suggesting the retention of a capital stock dependent on coal as an energy source.

Table 19

Italy

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	0.27 (7)	0.18 (3)	5.60 (34)	.72 (8)	6.78 (20)
IRON & STEEL	0.48 (12)	0.56 (11)	0.69 (4)	1.59 (19)	3.31 (10)
OTHER INDUSTRIAL	2.27 (56)	3.52 (68)	6.21 (38)	1.97 (23)	13.98 (41)
OTHER SECTORS[2]	1.01 (25)	0.90 (17)	3.94 (24)	4.34 (50)	10.18 (29)
TOTAL	4.03 (100)	5.16 (100)	16.44 (100)	8.62 (100)	34.25 (100)
1970					
TRANSPORTATION	.31 (4)	.07 (1)	16.21 (29)	.19 (3)	16.79 (21)
IRON & STEEL	1.01 (11)	.74 (8)	1.62 (3)	3.66 (50)	7.03 (9)
OTHER INDUSTRIAL	4.78 (54)	6.55 (68)	19.24 (35)	1.24 (17)	31.82 (39)
OTHER SECTORS	2.80 (31)	2.26 (23)	18.24 (33)	2.19 (30)	25.49 (31)
TOTAL	8.90 (100)	9.62 (100)	55.31 (100)	7.28 (100)	81.13 (100)
1978					
TRANSPORTATION	.46 (4)	.25 (1)	21.53 (33)	.06 (1)	22.29 (21)
IRON & STEEL	1.59 (12)	2.24 (11)	.95 (2)	4.03 (68)	8.81 (9)
OTHER INDUSTRIAL	6.26 (49)	9.62 (48)	20.83 (32)	.75 (13)	37.45 (36)
OTHER SECTORS	4.50 (35)	8.16 (40)	21.29 (33)	1.06 (18)	35.01 (34)
TOTAL	12.81 (100)	20.27 (100)	64.60 (100)	5.90 (100)	103.56 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and other.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

Table 20 presents Japanese energy consumption by sector and by source. It is a picture of a high growth, highly capital intensive economy that is dependent, as we shall see later, to a large extent on imported energy sources. Natural gas, imported by tanker, makes only a small contribution to Japanese energy requirements, and is mostly utilized in the residential sector. The dominant fuel source has changed from coal in 1960 to petroleum by 1970, and petroleum's dominance increased over the 1970-78 period.

There has been fairly rapid growth in hydro and nuclear power consumption with industrial sectors, other than iron and steel, exhibiting the strongest growth in the consumption of this fuel source. It is interesting to note that coal consumption in the iron and steel sector has remained close to its 1970 level throughout the 1970-78 period. This follows after a very rapid increase over the 1960-70 period. This is contrary to the experience in some of the other sample countries where we have seen a sharp decline in coal consumption in the iron and steel sector.

However, the most rapid growth is seen in petroleum consumption, particularly in the other industrial area. In fact, we have seen a decline in petroleum consumption within the iron and steel sector, and that decline began after peak consumption in 1973. This fact presumably represents shifts in production

Table 20

Japan

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)1

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	0.43 (5)	- (--)	7.27 (36)	4.04 (14)	11.73 (20)
IRON & STEEL	1.28 (16)	- (--)	2.47 (12)	6.59 (23)	10.34 (17)
OTHER INDUSTRIAL	5.04 (62)	.81 (41)	6.49 (32)	13.86 (47)	26.21 (44)
OTHER SECTORS[2]	1.43 (17)	1.16 (59)	3.87 (19)	4.73 (16)	11.18 (19)
TOTAL	8.18 (100)	1.97 (100)	20.10 (100)	29.22 (100)	59.46 (100)
1970					
TRANSPORTATION	0.97 (3)	- (--)	29.71 (25)	1.42 (4)	32.10 (17)
IRON & STEEL	4.51 (17)	-0.54 (-11)	10.10 (8)	28.28 (79)	42.34 (23)
OTHER INDUSTRIAL	15.26 (57)	1.66 (34)	45.27 (38)	3.23 (9)	65.43 (35)
OTHER SECTORS	6.17 (23)	3.74 (77)	34.07 (29)	3.05 (8)	47.03 (25)
TOTAL	26.91 (100)	4.86 (100)	119.15 (100)	35.98 (100)	186.90 (100)
1978					
TRANSPORTATION	1.29 (3)	- (--)	45.57 (27)	- (--)	46.86 (19)
IRON & STEEL	6.13 (14)	0.69 (8)	5.98 (4)	25.27 (83)	38.06 (15)
OTHER INDUSTRIAL	20.85 (49)	1.93 (21)	77.04 (45)	2.54 (8)	102.37 (40)
OTHER SECTORS	14.36 (34)	6.57 (71)	41.30 (24)	2.84 (9)	65.07 (26)
TOTAL	42.63 (100)	9.19 (100)	169.89 (100)	30.65 (100)	252.36 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and other.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

efficiency, substitution to other fuel sources and some reduction in production growth.

The Japanese transportation sector has become almost completely dependent on petroleum products, whereas in 1960, 34 per cent of this sector was fueled by coal and other solid fuel products.

The Swedish economy (Table 21) has shown some movement away from petroleum and coal during the 70s towards energy arising from nuclear and hydro sources. This has been particularly evident in the commercial and residential sectors, where not only is this shift evident, but also where some decline in consumption is also seen. Due to the unavailability of accessible quantities of natural gas, Sweden has shown an increasingly greater reliance on nuclear and hydro sources than any other economy in our sample, showing substitution to electric power from both petroleum and coal sources.

V Snapshots of Energy Balances

We now turn to a series of snapshots of energy balances for our sample of countries taken in the year 1977. These charts are attempts to picture the composition of energy supplies as they enter the economies and their final distribution to the economies' various sectors. In the charts the energy supply requirements by source of supply are proportionately represented on the left hand side -- coal, the various sources of

Table 21

Sweden

Sectoral Breakdown by Energy Source
(million tons of oil equivalent)[1]

	NUCLEAR & HYDRO	NATURAL GAS	PETROLEUM PRODUCTS	COAL	TOTAL
1960					
TRANSPORTATION	.14 (5)	- (--)	2.64 (25)	.09 (1)	2.87 (16)
IRON & STEEL	.30 (12)	- (--)	.74 (7)	.62 (13)	1.66 (9)
OTHER INDUSTRIAL	1.32 (53)	.06 (55)	2.56 (24)	3.09 (65)	7.04 (39)
OTHER SECTORS[2]	0.75 (30)	.05 (45)	4.59 (44)	0.98 (21)	6.36 (36)
TOTAL	2.51 (100)	.11 (100)	10.53 (100)	4.78 (100)	17.93 (100)
1970					
TRANSPORTATION	.18 (4)	- (--)	4.75 (21)	.01 (..)	4.93 (16)
IRON & STEEL	.48 (10)	- (--)	1.10 (5)	.79 (18)	2.37 (7)
OTHER INDUSTRIAL	2.47 (50)	.08 (73)	5.52 (25)	2.96 (69)	11.03 (35)
OTHER SECTORS	1.77 (36)	.03 (27)	11.02 (49)	0.55 (13)	13.37 (42)
TOTAL	4.90 (100)	.11 (100)	22.39 (100)	4.31 (100)	31.70 (100)
1978					
TRANSPORTATION	.18 (2)	- (--)	5.98 (27)	- (--)	6.16 (19)
IRON & STEEL	.42 (6)	- (--)	.70 (3)	.92 (22)	2.04 (6)
OTHER INDUSTRIAL	2.98 (43)	.01 (11)	5.40 (25)	3.36 (78)	11.75 (35)
OTHER SECTORS	3.39 (49)	.08 (89)	9.78 (45)	.01 (..)	13.25 (40)
TOTAL	6.97 (100)	.09 (100)	21.86 (100)	4.29 (100)	33.20 (100)

1 Figures in brackets indicate percentages within groupings.

2 Residential, commercial and other.

Source Energy Balances of OECD Countries, 1974/78, International Energy Agency.

electricity, natural gas and crude petroleum. In the centre, the inputs and outputs associated with electric power generation and petroleum refining are represented. On the right, the "final use" is pictured, again proportionately to the rest of the chart. This category represents all energy consumed by the industrial sector, the transportation sector, other sectors which include commercial and residential, and nonenergy use.[5] An attempt has been made in this series of charts to illustrate the linkages between the various supply sources and final use sectors.

For example, in Chart 4 which presents the Canadian picture, the contribution of coal as a primary fuel source for energy generation can be clearly traced. It is over 22 per cent of total energy requirements in 1977, is partly utilised in the generation of electricity, and in the final use category, fuels a little over 10 per cent of total consumption, being predominant as would be expected in industrial usage.

This set of charts reveals the differing supply/end use distribution amongst the countries. In Italy, Japan and France (Charts 10, 9 and 7) we see that imported sources of supply make up a large proportion of total energy supplied. We will return to this particular factor later in the paper. The high degree of dependence of the Japanese economy on petroleum in 1977 is clearly evident. The fuel, to a large extent, permeates all phases of final energy consumption - 68 per cent (see Chart 9). Imported fuels make up over 90 per cent of total energy requirements in Japan in that particular year.

Chart 4

Energy Balance Sheet, 1977 - Canada

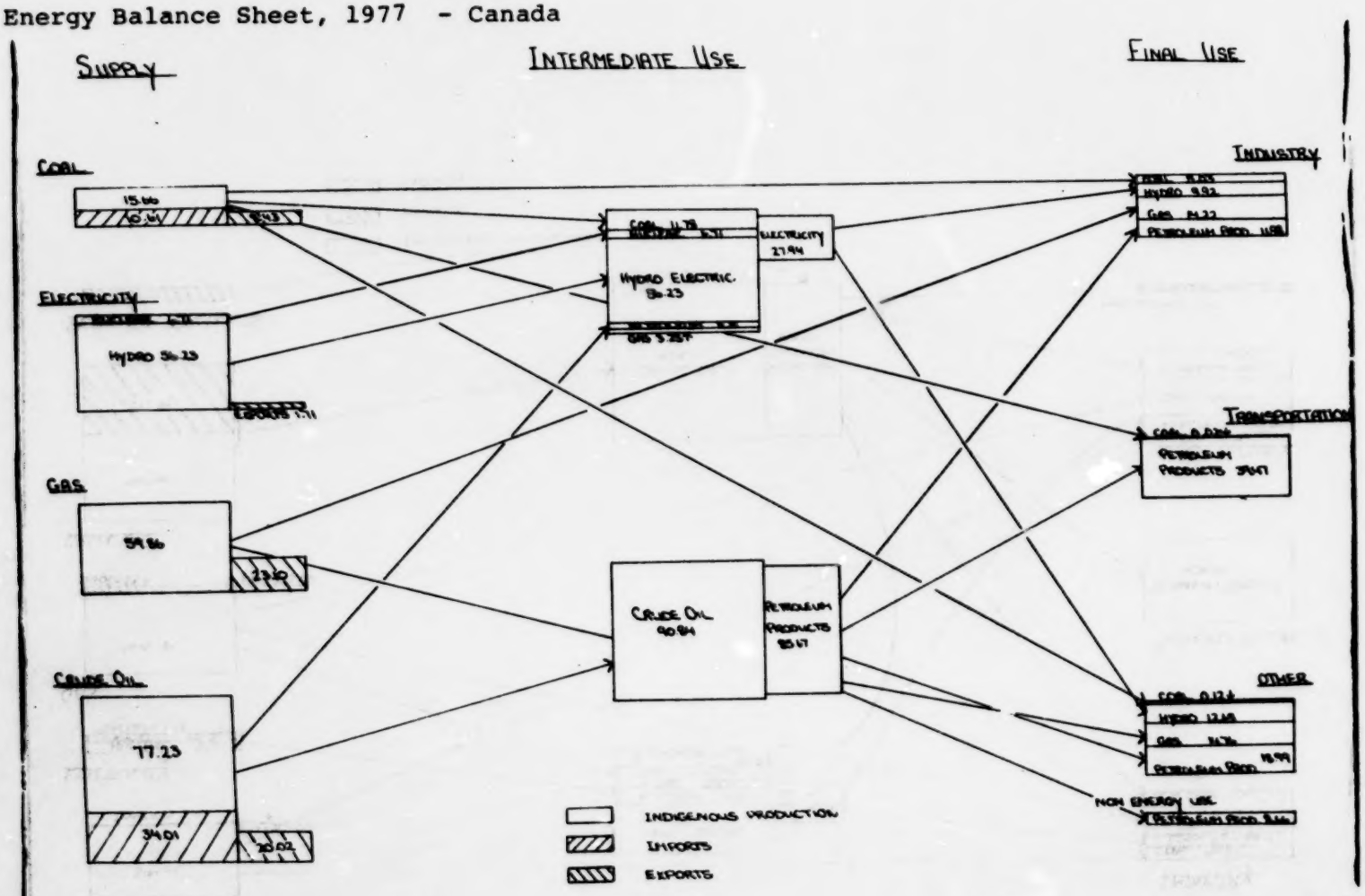


Chart 5

Energy Balance Sheet, 1977 - United States

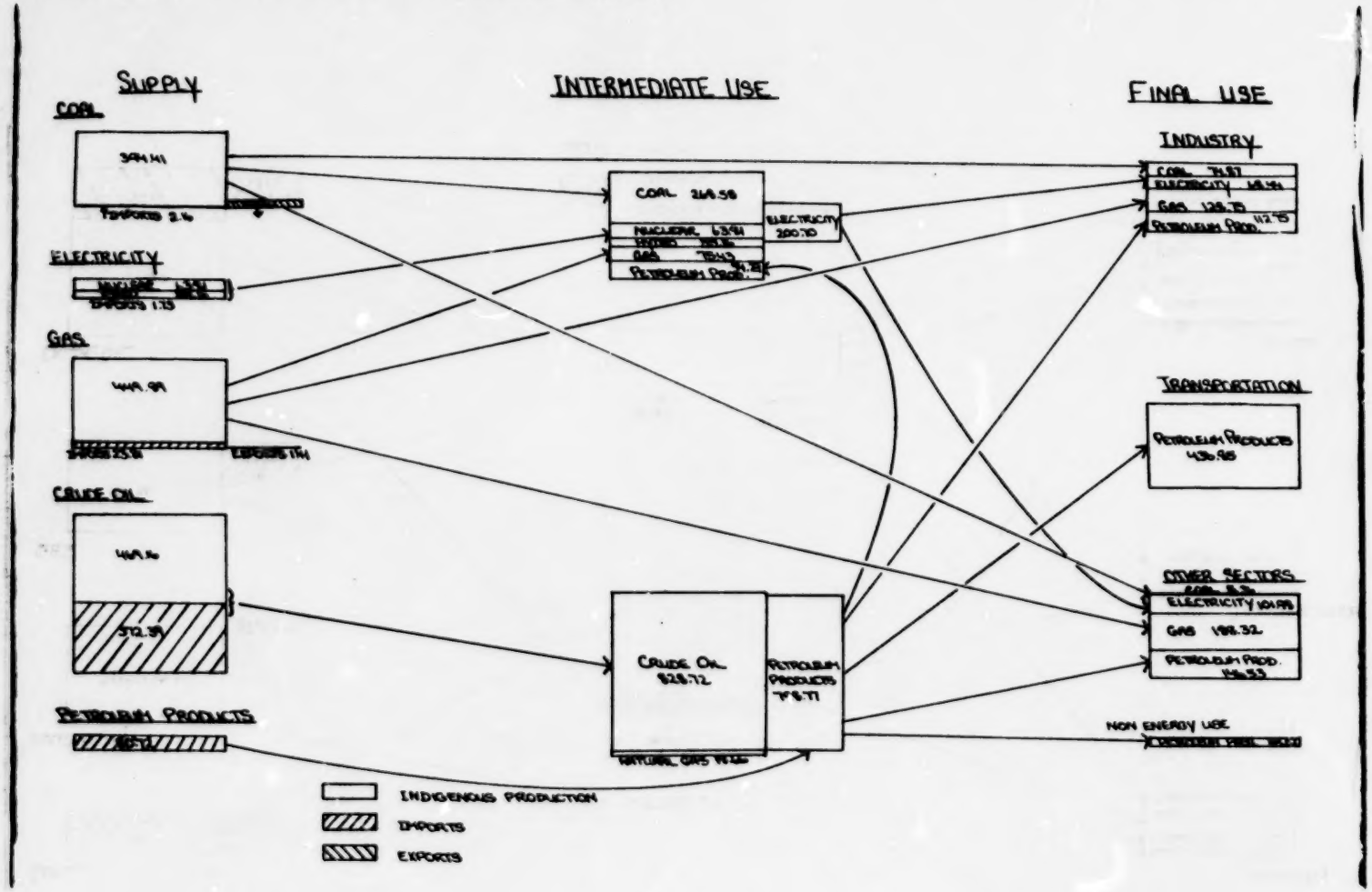


Chart 6

Energy Balance Sheet, 1977 - United Kingdom

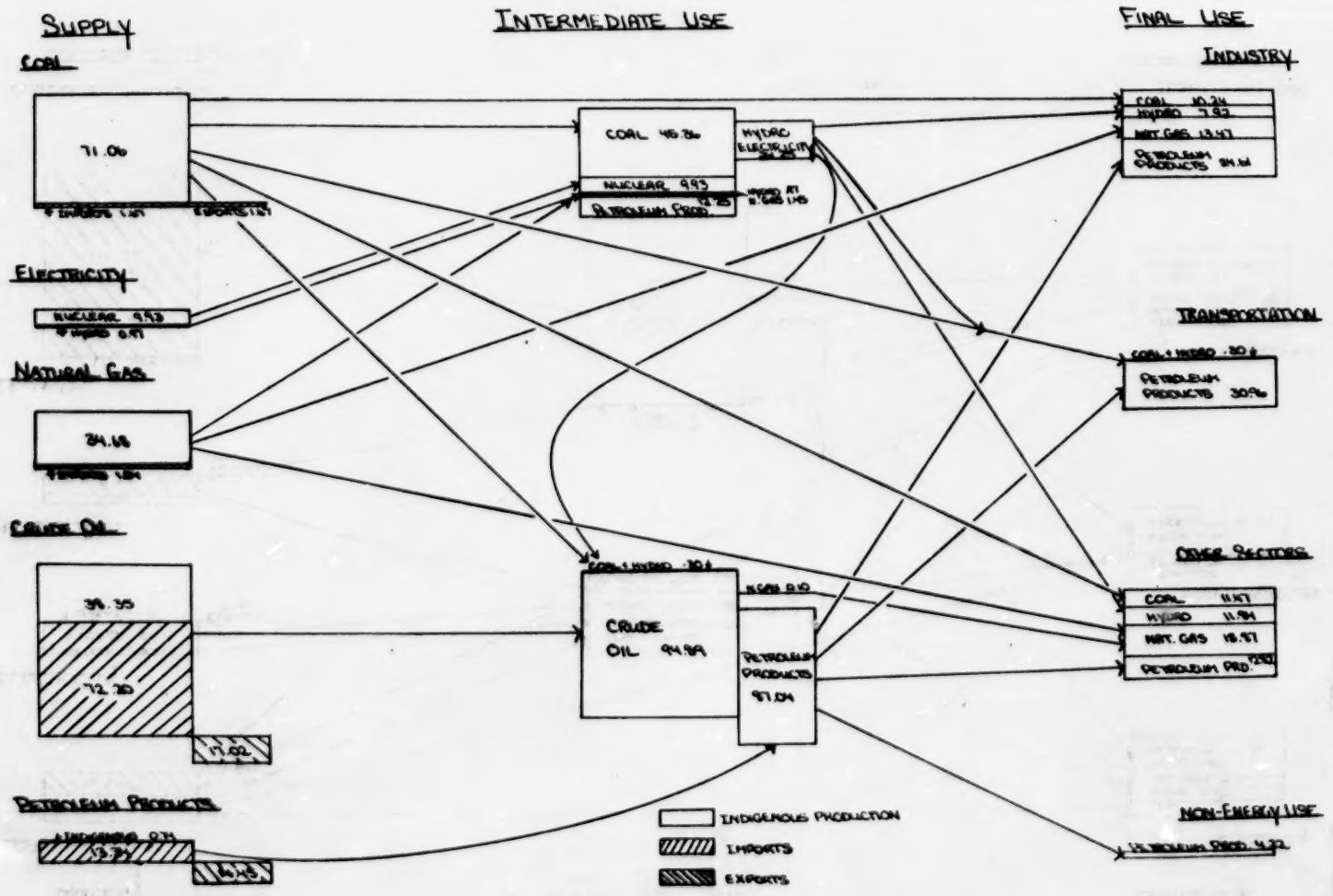


Chart 7

Energy Balance Sheet, 1977 - France

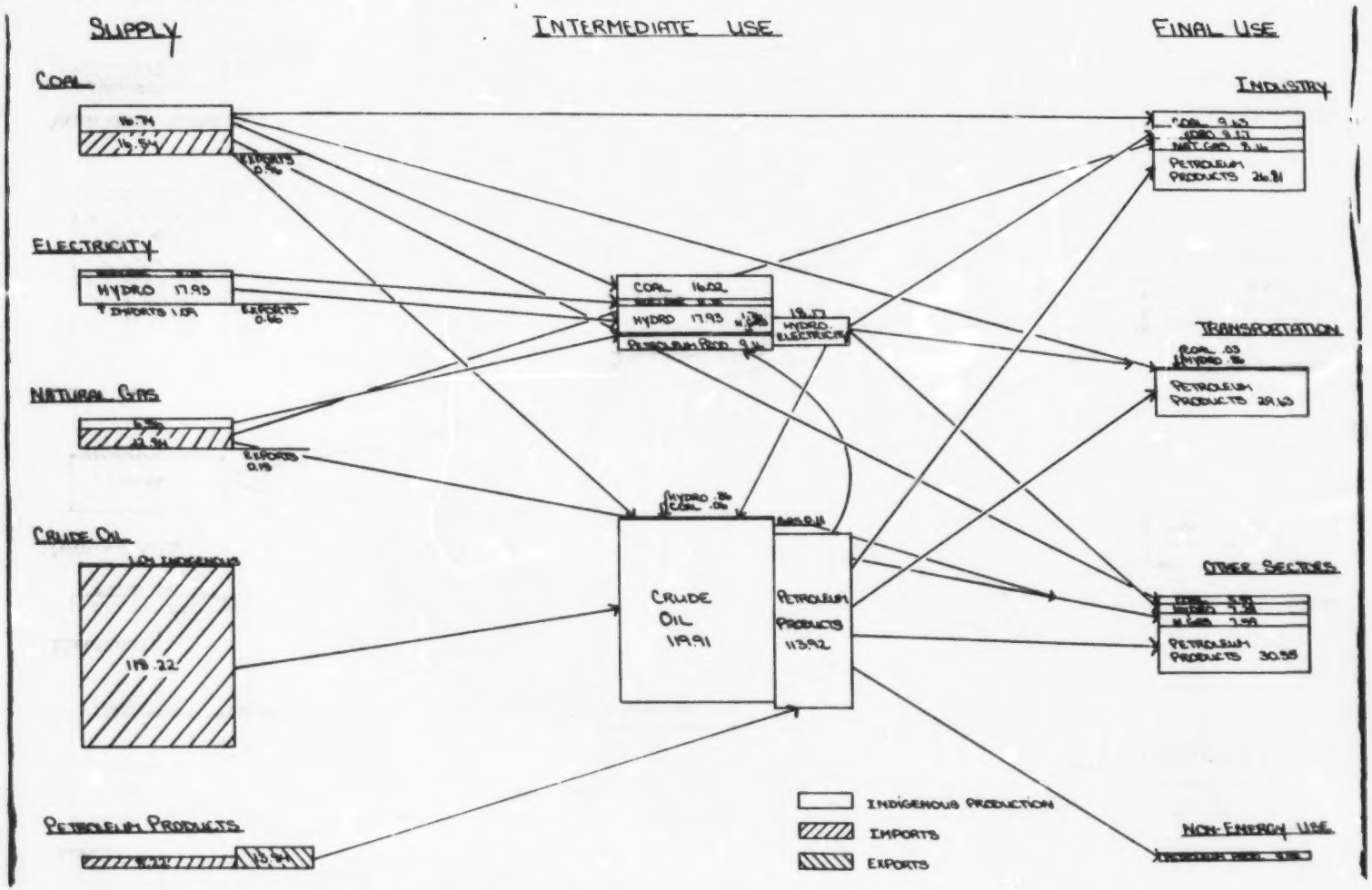


Chart 8

Energy Balance Sheet, 1977 - Germany

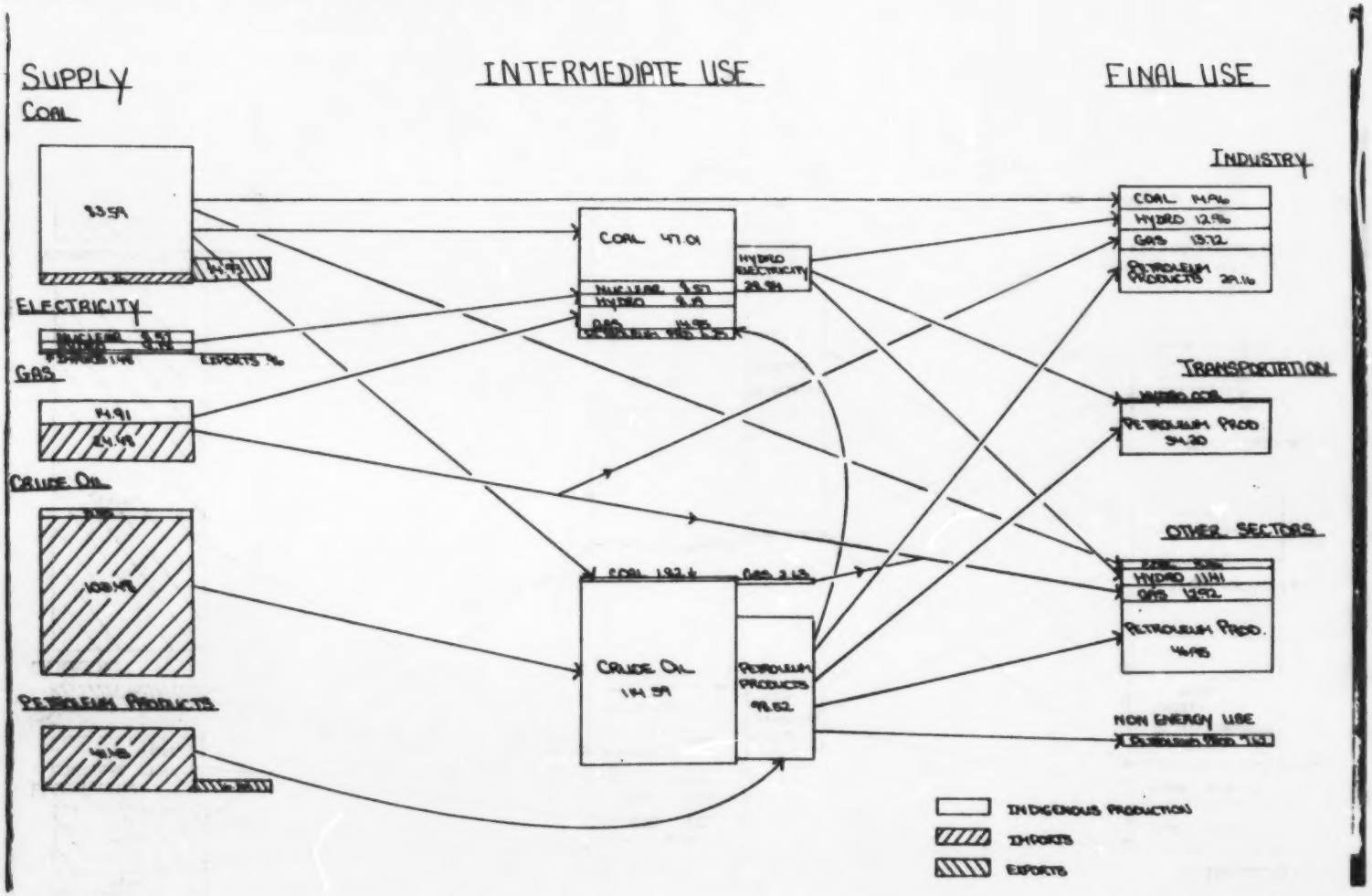


Chart 9

Energy Balance Sheet, 1977 - Japan

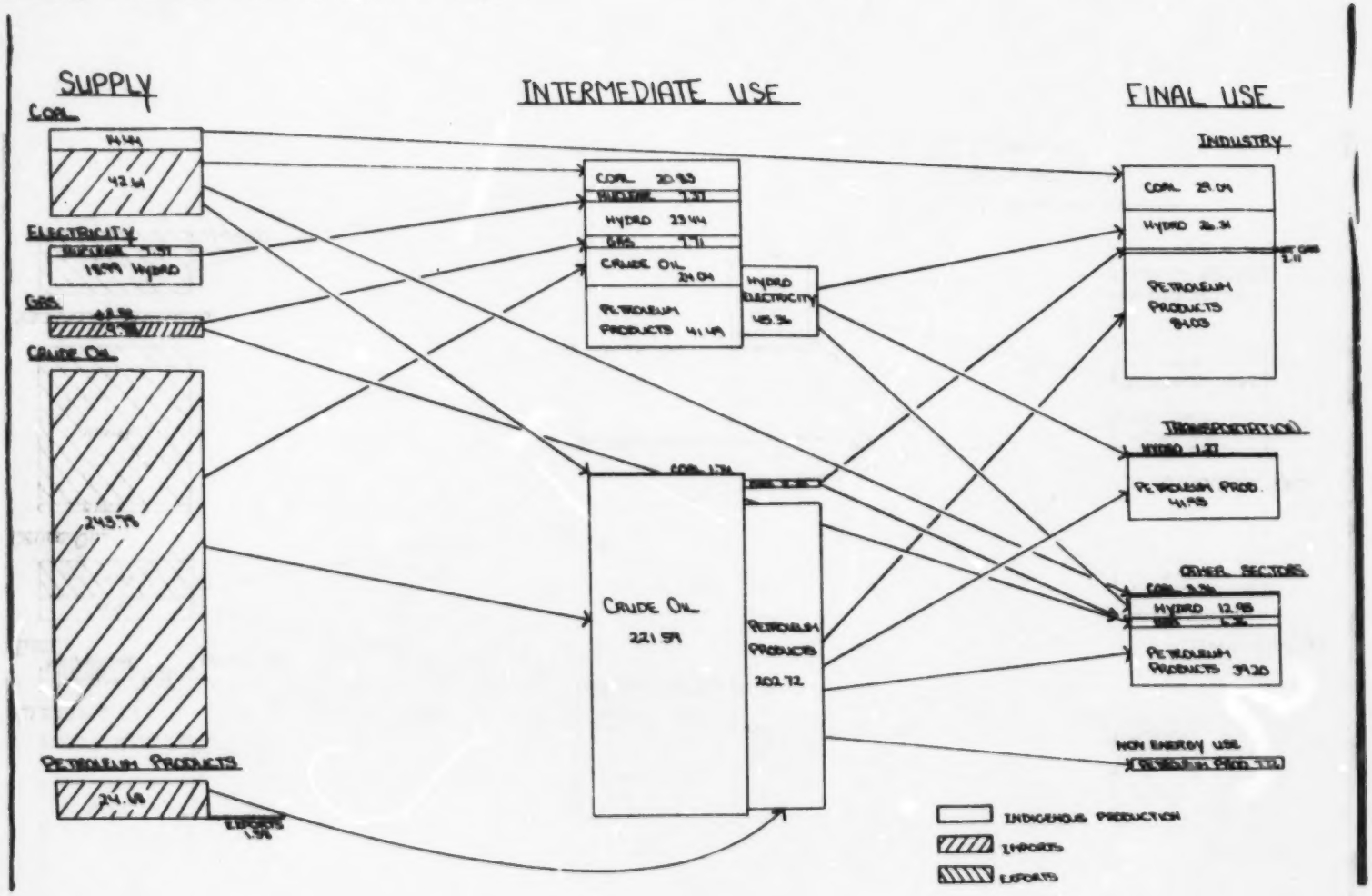


Chart 10

Energy Balance Sheet, 1977 - Italy

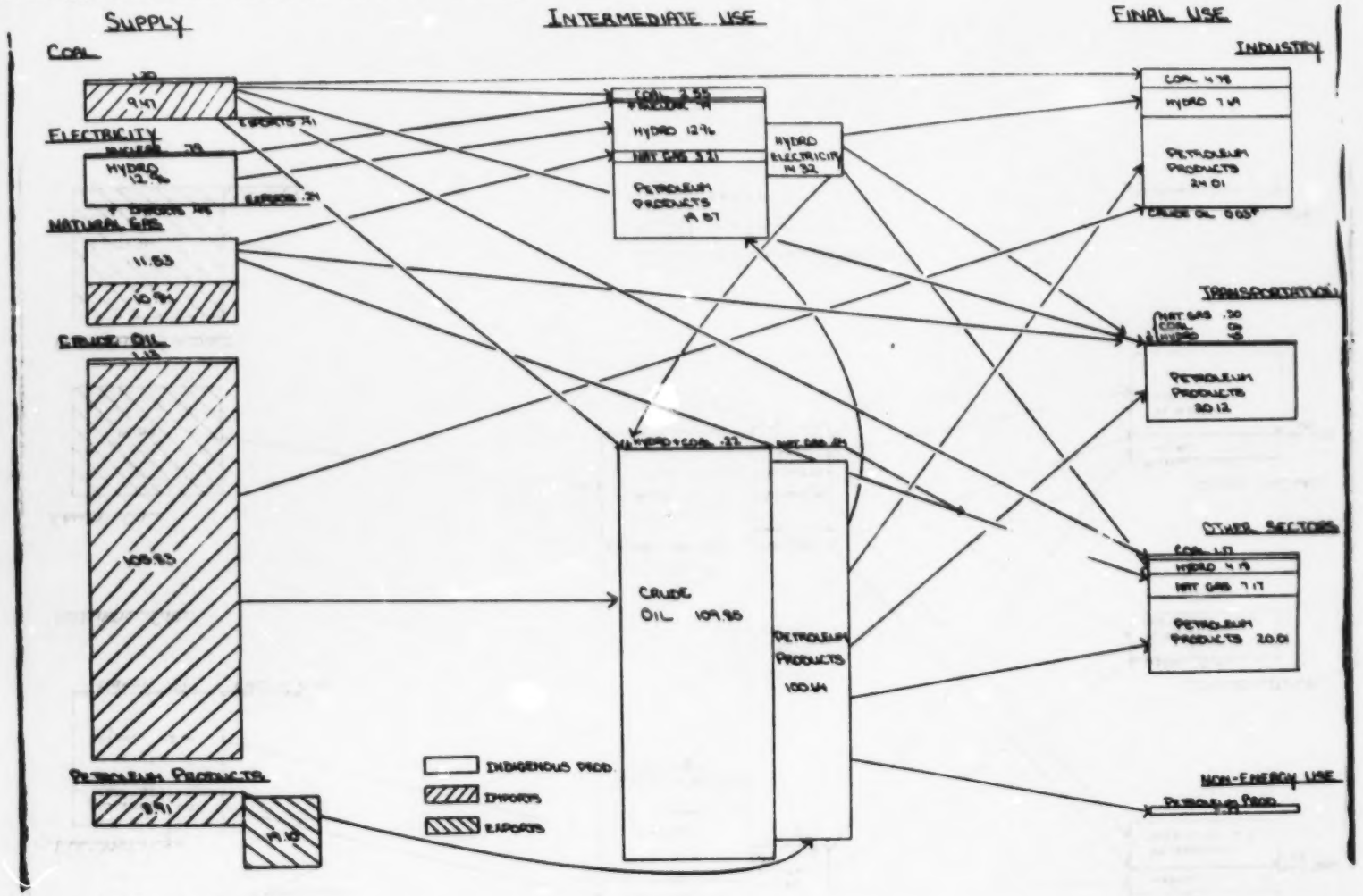
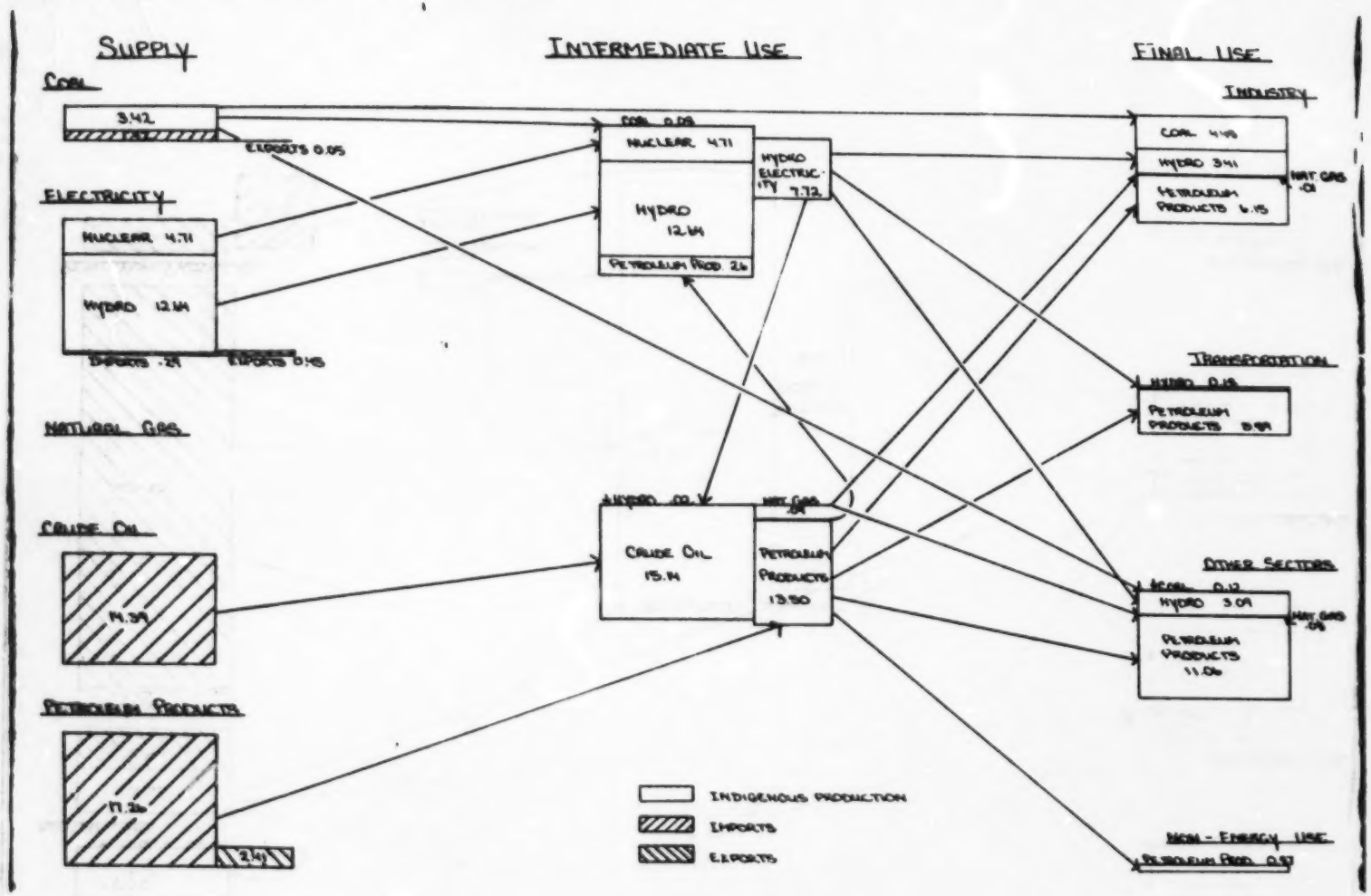


Chart 11

Energy Balance Sheet, 1977 - Sweden



Easily apparent in these charts are factors such as the complete absence of natural gas supplies in Sweden (Chart 11) and the variation in the size of the "final use" sectors. For example, energy consumption in the industrial sector in Japan (Chart 9) completely overshadows the other two major sectors, whereas in the United States (Chart 5) and Canada (Chart 4) there is a more balanced distribution amongst the sectors. This balancing is not necessarily desirable, but is rather, perhaps, an indication of less productive distribution of energy use in the latter two countries.

VI Import Dependency

In an earlier section we referred to the degree of import dependence amongst our sample countries. Table 22 presents a comparison of the various countries' dependence on imported sources of energy over the 1960-1979 period. Canada alone switched to the role of a net exporter of all sources of energy over a good part of the period. However, the Canadian decision in 1974 to restrict exports of crude petroleum is clearly shown, as a decreasing net exporter position becomes apparent towards the end of the decade.

Most interesting are the trends over time as many of the countries move to a much greater dependence on imported sources. The United States, until very late in the 1970s, has shown a trend towards a growing dependence, although at its peak only a

Table 22

International Comparison of Import Dependency
(net imports as percentage of total energy requirements)

	1960	1965	1970	1972	1974	1975	1976	1977	1978	1979
CANADA	21.4	10.9	-3.8	-12.3	-13.5	-9.0	-5.9	-4.3	-5.3	-6.7
UNITED STATES	6.4	7.6	8.6	12.8	16.6	17.8	20.6	24.3	22.8	22.0
GERMANY	11.3	34.8	49.9	54.6	52.6	55.8	58.7	58.8	56.6	58.0
FRANCE	40.9	55.2	73.2	79.3	84.4	75.2	82.4	78.7	75.2	77.6
UNITED KINGDOM	27.3	38.6	49.1	52.9	53.1	45.5	40.8	26.3	21.8	12.7
ITALY	60.4	81.3	83.3	84.6	86.1	83.4	85.2	83.6	84.5	85.5
JAPAN	40.3	67.5	86.9	89.3	93.9	91.5	90.5	91.7	89.0	89.6
SWEDEN	59.1	58.8	74.9	66.7	66.9	65.5	61.8	62.3	55.8	60.7

1 Minus sign indicates net exporter.

Source OECD, Energy Balances of OECD Countries, 1975/79 and earlier issues.

little over 24 per cent of U.S. total energy requirements were supplied by imports. The United Kingdom's dependence on imports peaked in 1974 and then has fallen off sharply to below 1960 levels. This pattern arises from many factors including a reduction in overall total energy requirements in the latter half of the 70s, and the gradual occurence of indigenous fuel sources such as North Sea oil and gas.

As the period progressed Germany has seen increasing dependency, which has only stabilised in the latter part of the 1970s. Sweden has always been fairly dependent on imported sources, but has managed to effect some reduction of late. However, she ranks in the same range as Germany in terms of dependence on imports.

As mentioned previously, Japan, France and Italy are at the upper end of the range in our comparison, with Japan emerging as the most dependent on imported fuels. Both France and Japan have shown some progress in reducing dependence to a small degree, however Italy has remained at the same level thoughout most of the 1970s.

VII Energy Prices and Taxation

In attempting to compare energy prices across a range of countries, several problems arise. These include not only problems such as data availability and comparability of valuation techniques, but also problems in that the structure in energy source

use varies within the countries included in our sample. In this paper, we have selected for comparison purposes, an energy source that is widely used in all the countries in question, and one for which price and taxation data are available. That fuel is standard low octane gasoline.

Table 23 presents the nominal and real price of gasoline and the effective rate of gasoline taxation in eight countries over the 1970-79 period. These prices are expressed in the local currencies of the countries, and are then indexed on a 1970=100 base. The real price has been calculated by deflating the nominal price by the consumer price index for the relevant country. The effective rate of gasoline taxation is the gasoline tax per gallon divided by the net-of-tax price per gallon.

In order to make cross-country comparisons from this table, one other piece of information is necessary. That is "what is the relative level of prices in the various countries?" Table 24 supplies this data, for in it, the price for 100 litres of standard gasoline is expressed in U.S. dollars in both nominal and real terms. From it we can observe that France and Italy had the highest nominal (and real) price in 1968 and retained that position throughout the period in nominal terms. Similarly the North American countries have retained their position as having the lowest prices. Chart 12 expresses the same picture on 1970=100 based indices, showing the change over the 1970-79 period.

TABLE 23: THE PRICE OF STANDARD LOW OCTANE GASOLINE, and ASSOCIATED EFFECTIVE TAX RATES

CANADA

	Nominal Price	Real Price	Effective Rate of Gas Tax
	1970 = 100		%
1970	100.0	100.0	82.2
1971	102.8	102.6	75.9
1972	102.8	95.5	91.8
1973	102.8	89.1	71.3
1974	118.3	92.3	62.5
1975	127.5	89.8	77.7
1976	162.4	106.5	94.4
1977	172.5	104.6	64.8
1978	182.6	101.4	59.5
1979	208.8	106.3	47.9

UNITED STATES

Nominal Price	Real Price	Effective Rate of Gas Tax
1970 = 100		%
100.0	100.0	44.2
107.6	103.1	40.9
106.8	99.1	40.9
114.2	100.0	38.1
132.6	104.7	24.5
150.0	108.6	25.1
165.3	113.2	25.1
171.7	110.2	22.7
177.2	105.5	25.0
242.4	130.1	18.2

United Kingdom

	Nominal Price	Real Price	Effective Rate of Gas Tax
	1970 = 100		%
1970	100.0	100.0	257.1
1971	103.0	94.1	222.8
1972	106.0	90.3	214.4
1973	108.0	84.3	150.0
1974	126.3	85.0	101.6
1975	226.9	122.9	64.9
1976	242.4	112.8	74.5
1977	240.8	96.6	118.7
1978	234.7	86.8	140.2
1979	365.4	119.4	46.9

Italy

Nominal Price	Real Price	Effective Rate of Gas Tax
1970 = 100		%
100.0	100.0	364.3
116.9	111.3	355.0
116.9	105.4	355.3
116.8	95.0	335.2
146.2	99.9	214.1
220.9	129.0	214.1
296.2	148.2	184.9
369.3	157.8	257.3
369.3	140.7	260.2
392.3	130.3	208.9

Germany

	Nominal Price	Real Price	Effective Rate of Gas Tax
	1970 = 100		%
1970	100.0	100.0	263.5
1971	102.7	97.5	206.9
1972	106.7	96.0	257.5
1973	111.7	94.1	239.1
1974	137.2	108.0	157.1
1975	149.0	110.7	165.0
1976	154.0	109.7	133.7
1977	155.5	106.9	153.1
1978	156.7	104.7	143.1
1979	169.6	109.0	125.7

France

Nominal Price	Real Price	Effective Rate of Gas Tax
1970 = 100		%
100.0	100.0	289.5
101.0	95.8	270.6
104.8	93.4	266.4
104.8	87.1	333.5
152.2	111.2	134.5
159.9	104.6	131.3
166.6	99.8	121.2
197.8	108.1	153.5
207.4	103.8	131.2
212.5	96.1	175.7

Japan

	Nominal Price	Real Price	Effective Rate of Gas Tax
	1970 = 100		%
1970	100.0	100.0	141.8
1971	85.6	80.6	118.4
1972	108.0	96.9	105.4
1973	119.8	97.3	100.0
1974	174.3	113.9	49.7
1975	244.9	143.1	50.1
1976	250.3	133.7	71.4
1977	253.8	125.5	59.3
1978	246.5	117.4	72.7
1979	246.8	113.5	72.0

Sweden

Nominal Price	Real Price	Effective Rate of Gas Tax
1970 = 100		%
100.0	100.0	..
114.1	106.6	212.4
116.5	102.2	194.2
116.5	96.2	191.6
142.3	107.1	114.0
163.6	112.1	143.1
181.1	112.4	102.9
187.1	104.3	94.7
197.6	100.2	152.4
244.2	115.5	86.7

Notes to Table on International Comparison of Gasoline Pricing and Taxation

Nominal Price:	Price in local currency is average price paid in main consuming areas at 1st January each year for Octane RM-94 and below; price per 100 litres
Real Price:	Nominal price deflated by Consumer Price Index for country
Effective Rate of Gas Tax:	Value of gasoline tax per gallon divided by net-of-tax price per gallon.
Source:	Nominal Prices obtained from OECD, Energy Statistics, 1975/1977, International Energy Agency, Paris 1979. CPI Indexes taken from International Monetary Fund, International Financial Statistics, March 1980 and 1977 Supplement. Gasoline taxation calculations were taken from "Gasoline Taxation Can Play an Important Role in Cutting Consumption, Reducing Oil Deficits" in IMF Survey, January 18, 1980, with additional data for Sweden and updates for several countries from U.S. Department of Energy, International Petroleum Annual 1979.

From Table 23, we can see that Japan, Italy and the United Kingdom have had the fastest rate of increase in the nominal price of gasoline with Germany registering the slowest rate. However, it should be recalled that the German price began from a much higher base thus, expressed in U.S. dollars, the German price was higher. The information in Table 24 and Chart 6 includes exchange rate movements so that we must be careful in concluding "who was the slowest or the fastest".

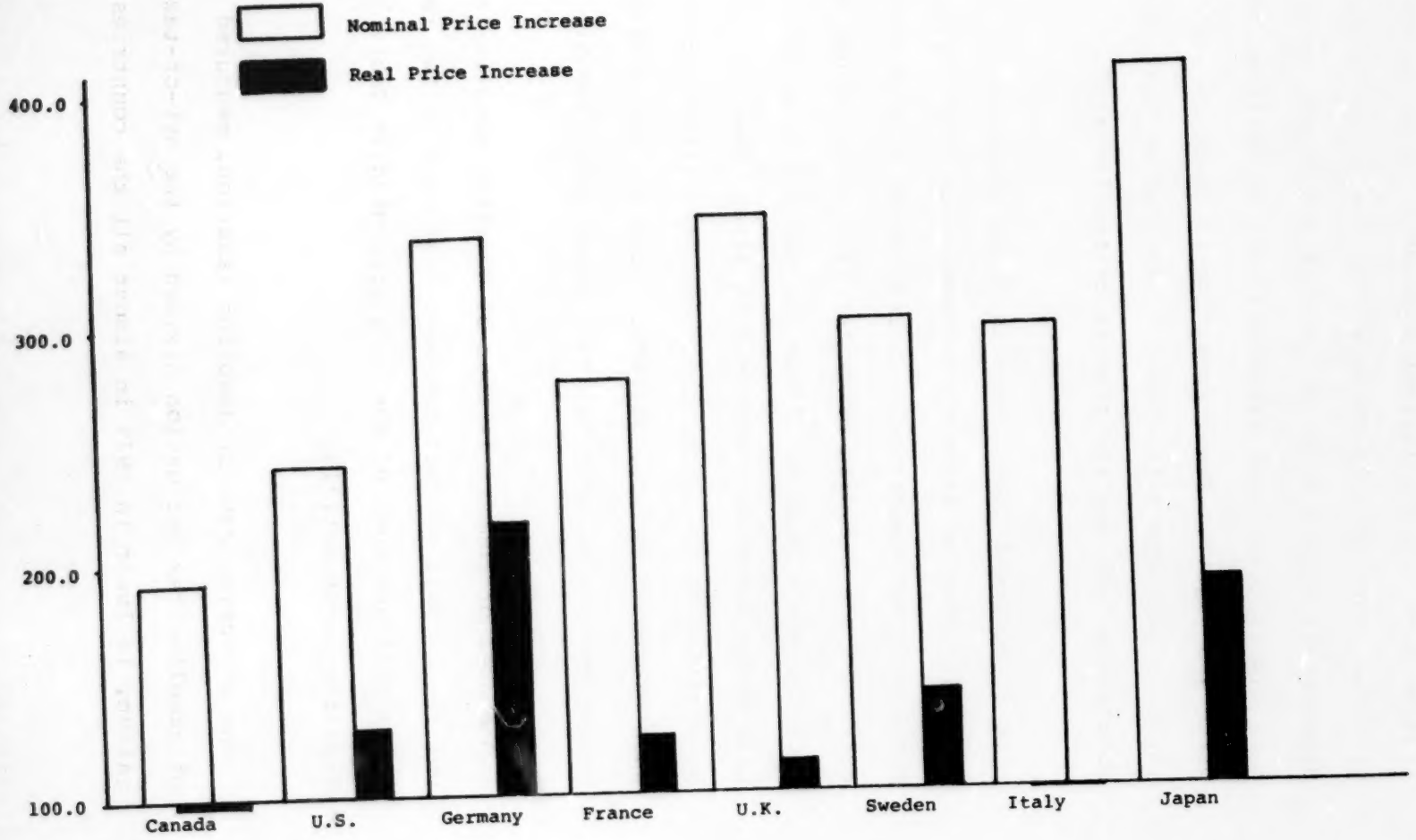
It is apparent that Canada is among those at the lower end of the scale when we attempt to compare its gasoline price with those of other countries. In real terms when measured in local currency, the Canadian price has fluctuated around the 1970 level over the whole period. Italy has had the greatest increase in real price terms when measured in lire. However, because of the devaluation of the lire, there has been little price movement when expressed in U.S. dollars. Such are the difficulties of making meaningful international price comparisons.

One area of concern is that of domestic gasoline taxation policies. This subject has been discussed in two recent IMF documents[6] and much of the data presented in Table 23 evolves from the first article.

The effective rate of gasoline taxation, measured as the value of gasoline tax per gallon divided by the net-of-tax price per gallon, is lower in 1979 in almost all the countries in question

Chart 12

Trends in Regular Low Octane Gasoline Prices
(Price in $US per 100 litres, 1970=100)



Source: Table 24.

Table 24

Gasoline Prices in Eight Countries in a Common Currency, 1968-1979
(Expressed in $U.S. per 100 litres of standard gasoline)

	1968	1970	1972	1973	1974	1975	1976	1977	1978	1979
Nominal Price										
Canada	9.1	10.1	10.4	10.4	12.9	14.0	17.4	18.6	18.2	19.5
United States	9.0	9.2	9.8	10.5	12.2	13.8	15.2	15.8	16.3	22.3
Germany	15.4	15.1	16.1	21.3	28.1	34.2	32.5	36.4	41.2	51.3
France	19.5	18.9	19.8	23.9	33.9	37.8	39.0	41.8	46.3	52.3
United Kingdom	14.2	16.8	17.8	19.7	20.5	37.3	32.3	28.7	31.3	58.1
Sweden	17.0	16.4	19.2	21.7	26.4	34.0	34.9	38.5	36.0	49.3
Italy	19.2	20.8	24.3	25.8	30.4	43.0	45.6	54.8	55.1	62.0
Japan	15.0	12.5	13.5	17.1	28.0	36.1	36.6	38.5	46.2	51.0
Real Price (Expressed in $1975)[1]										
Canada	14.0	14.4	13.7	12.8	14.3	14.0	16.2	16.0	14.4	14.1
United States	13.9	12.7	12.6	12.7	13.3	13.8	14.4	14.0	13.4	16.5
Germany	21.8	20.4	19.5	24.1	29.8	34.2	31.2	33.7	37.1	44.4
France	33.5	28.9	27.0	30.4	37.9	37.8	35.7	34.9	35.5	36.2
United Kingdom	29.3	31.0	28.0	28.4	25.5	37.3	27.7	21.3	21.4	35.0
Sweden	27.3	23.9	24.6	26.2	29.0	34.0	31.6	31.3	26.6	34.0
Italy	35.4	35.6	37.5	35.9	35.6	43.0	39.0	40.1	35.9	35.2
Japan	29.1	21.4	20.7	23.8	31.3	36.1	33.5	32.6	37.7	40.2

1 Nominal Price deflated by relevant country Consumer Price Index 1975=100.

Source Nominal Price data in $U.S. is taken from OECD, Energy Statistics, 1975/1977, Paris 1979, updated with additional data from U.S. Department of Energy, International Petroleum Annual 1979. Consumer price indexes taken from International Monetary Fund, International Financial Statistics, March 1980 and 1977 Supplement.

than it was at the beginning of the decade. In most cases, except that of Germany, the tax is a specific tax levied on a per gallon basis. (The German case is a combination of a specific tax and an ad valorem tax calculated as a percentage of the retail price.) The use of a specific tax means that as per gallon consumption falls, the taxation revenues also fall. This revenue loss may be compounded by conservation measures within a country.

The reduction in the effective rate of taxation can be attributed to several factors. The role of gasoline taxation in many countries has traditionally been one of acquiring revenues earmarked for highway maintenance and construction. If this were the only reason for taxation, one would expect that the effective rate would fall during and after the 1973-74 price increases, as the crude petroleum price increase would be very different (and much higher) than the inflationary factor involved in costs of highway maintenance and construction. However, this form of taxation is also part of a larger system of indirect taxation in many countries, and in some countries is not specifically tied to highway expenditures, for instance, in Canada and the United Kingdom.

There are many ways of viewing the role of gasoline taxation. Through taxation policies, a government can effectively shield the consumer from the full impact of gasoline price increases. The sharp fall in 1974 in the effective rates in every country in

our sample illustrates this point. One conclusion is apparent: the countries, such as Italy, that tax heavily before the OPEC price increases, still tax heavily relative to other countries. Canada is among those countries (Italy and Sweden are the others) which have had the lowest relative decline in the effective rate of taxation. However, the situations are not at all comparable since Canada had one of the lowest rates of taxation in 1970 to start with and still retains that position. France and Sweden had the greatest decline in effective taxation, and their positions have changed from that of the most heavily taxed to that of just a moderate level of taxation, though with some upswing in 1979 in the case of France.

It has been argued that taxation can be used as a tool of conservation policy, as well as being a source of revenue for governments. The conservation argument and its acceptability to the general public is dependent to a large degree upon the policy-maker's and the public's perception of the role of price in conservation policies. The revenue role is unargueable. One could suggest that ad valorem taxes such as those implemented by the Provinces of Quebec and Ontario are a much more efficient revenue-producing measure as they rise with price increases, whereas, as pointed out before, a specific tax will decline as conservation and price-induced effects reduce overall gallonage consumption. Research into the equability of gasoline taxation among consumers has suggested that it is somewhat regressive, penalizing middle and lower income consumers since gasoline consumption has such a low price elasticity.7

VIII Summary

In this paper we have drawn together comparisons of various measures of energy use for a set of eight industrialised countries over the decades of the 1960s and 1970s. These comparisons have extended to a glimpse of the distribution of usage of the various energy sources amongst industrial sectors within the economies of our eight sample countries.

It has been found that to generalise Canada as an inefficient, wasteful energy user is a gross oversimplification without taking factors such as population and real output trends into consideration. We have not attempted to include a sophisticated adjustment for factors such as weather, land mass and other geographical considerations. Yet these, too, are factors that should be evaluated before producing definitive comparisons of energy use and intensity.

We briefly viewed trends in energy pricing and taxation in our country set, and have indeed reinforced the notion that, especially in real terms, Canada has been able to rely not only on plentiful energy sources, but also on cheap energy over the two decades in question. This conclusion would remain in all likelihood, no matter which energy form was utilised in our comparison.

Footnotes

1 OECD, Energy Balances of OECD Countries, 1975-1977, International Energy Agency, Paris, p. v.

2 Ibid, p. vii.

3 The negative entry in natural gas consumption in the iron and steel sector in Table 16 indicates the gas flows were utilized for non-energy purposes.

4 Reference was made to this latter factor in Mark Rodekohr, Recent Energy Consumption Trends in the European Economic Community Countries, Technical Memorandum, TM/IA/79-18, United States Department of Energy, Washington, D.C.

5 Non-energy petroleum products such as bitumen, lubricants, etc.

6 "Gasoline Taxation Can Play an Important Role in Cutting Consumption, Reducing Oil Deficits", in IMF Survey, February 18, 1980, "Gasoline Tax Burden is Analyzed to Assess Distributional Impact" in IMF Survey, International Monetary Fund, April 21, 1980.

7 "Gasoline Tax Burden...", op. cit.